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BLAIR ATHOL.

THE news of Blair Athol's recent death, coming as it does on the eve of our classic Northern race, in which the blaze-faced chestnut played so conspicuous a part eighteen years ago, cannot but impress us all the more mournfully for that reason; and well might one of his stanchest admirers, during a long and successful stud career spent under his watchful care, write to us in reference to his old favorite: "Upon my word I feel as if I had lost an old friend, and am quite melancholy." The leading features of Blair's Athol invariably commanded a full subscription; yet he failed to show at his best until he had again changed hands at the gigantic sale which followed upon the death of the late master of Middle Park. Blair Athol had always been the "horse of sensation," but he never gave plainer proof of his right to that title than when he was led into the ring on the last afternoon of the sale, the "clinching" bid for him being one of 12,500 guineas forthcoming on the part of the then newly-established Stud Company. It was at Cobham that he may be said to have done all his best things, and of that venture he may be regarded as the very mainstay and in gallant guise, and his slightly "switch" flag flying behind him, Blair Athol looked the embodiment of all that is grand and noble in horseflesh; while he bore inspection in his box right well, having both "sides" equally good, and he was never known to resent intrusion by any of those ebullitions of temper which we have come to regard as the privileged eccentricity of a father of the stud. Like all great horses, he had his enemies and detractors, who found more room, however, for railing against his frequent failure to get stayers, than the form in which the majority of his offspring were cast. We have heard the opinions of a

"BLAIR ATHOL," LATELY DECEASED, THE MOST VALUABLE RACEHORSE EVER KNOWN.

racing career have been learned by heart by every sporting tyro, in addition to particulars concerning his birth and parentage; so we sum up in brief by stating that he only twice knew defeat, once when, after a stormy passage across the Channel, he went down before Vermont in the Grand Prize of Paris, returning home in ample time, however, to give Ely some pounds in weight, and a clever beating over the New Mile at Ascot; and again when The Miner most unaccountably beat him in the Great Yorkshire Stakes, for which, however, he took ample revenge at Doncaster. For some reason he was withdrawn from active service after following up his Derby success with a St. Leger victory, and his owner and breeder, the late William I'Anson, who never kept a stallion at Blink Bonny Stud Farm, disposed of the chestnut to John Jackson, one of the leviathans of the ring in those days, and a well-known character in Yorkshire. At Fairfield, in that county, within sight of its capital's Minster towers, John Jackson had, shortly before his death, collected an important breeding stud, of which Blair Athol was destined for a time to be the head; but his sojourn at the newly-founded establishment was not a lengthy one, and at its dispersal the chestnut passed into the possession of William Blenkiron, of Middle Park, the scene of his labors for several years, until death laid his hand upon that most genial and successful of breeders, who had dipped deeply into his latest acquisition. The results were not so immediately apparent as might have been anticipated, albeit Blair sheet-anchor, as a glance at the fee demanded for his services and the prices realized by his yearling stock will duly testify. Prince Charlie was perhaps his first great card, though both he and Scottish Queen (a One Thousand Guineas winner in 1869) were musically inclined, and people began to talk of the inability of his stock to compass a distance of ground, a reproach, however, speedily to be wiped out by the doughty deeds of Craig Millar and Silvio, the former of whom seems not unlikely to fill the place vacated by his sire. We have enumerated only Blair Athol's "great winners," his lesser lights on the turf being more than we can trust ourselves to try and recount; but their names are legion, and not a race-goer of the last two decades but can recall some "bright, particular star" tracing his descent from the subject of this memoir. Most of his produce showed terrific speed, and could nearly all "race a bit"—hence Blair's popularity among breeders; though, of course, there were some found (and among them reputed good judges) to contend that he never begot a real stayer in his life, and there may be some shadow of truth in the assertion, Craig Millar and Silvio notwithstanding. As regards appearance, all who recollect the bald-faced chestnut in his box at the various haras where he held court, will concur in pronouncing the son of Stockwell and Blink Bonny as eminently worthy of his distinguished lineage, in shape, style, bearing and action. To see him led out with his rich coppery coat in its summer sheen, carrying his shapely head multitude of critics regarding "beauties and defects" in Blair Athol's conformation, yet the former fairly overwhelmed the latter, and the worst that could be imputed to the mighty chestnut was that his forelegs perhaps stood a little too much under him, albeit not in his case associated with faulty shoulders. We saw him at Pound Stud Farm early this spring in all his wonted health and vigor, with nothing in the shape of hollow back or wasted quarters indicating that he had attained the years of man's majority; and though opinions will probably long continue to differ concerning the measure of benefit his protracted services have conferred on the English stud, yet take him all in all—his high lineage, his distinguished bearing, his sensational turf career, his success as a stallion—'twill be long indeed before we look upon his like again.—*Illustrated Sporting and Dramatic News.*

UTILIZING ORANGE-PEEL.

A GENTLEMAN in Manchester claims to have succeeded in applying orange-peel to a very useful purpose. Orange-peel dried in or on the oven, until all the moisture has been expelled, becomes readily inflammable, and serves admirably either for lighting fires or for resuscitating them when they have nearly gone out. Thoroughly dried orange-peel will keep for a very long time, and might be collected while the fruit is in season, and stored for winter use.

THE COMMERCIAL MUSEUM OF BRUSSELS.

Report by U. S. Consul John Wilson, Brussels, Belgium.

The Belgian Government has just opened in this city a commercial museum, under the control of the minister of foreign affairs. The declared intention of the government in creating this museum is for the exhibition of specimens of both raw materials and manufactures of all countries, and thus make it subserve the same purpose in commercial science as do mineralogical, geological, anatomical, and other similar collections in natural science. It is thought that by thus uniting in one building specimens of the industrial products of all nations, Belgian merchants and manufacturers will be furnished with increased facilities for practically studying the trade of other countries, and that the Belgian manufacturer, by there seeing samples of manufactures adapted to the local tastes and necessities of foreign nations, may better learn the conditions upon which similar articles can be profitably manufactured, thus obviating the errors so often committed by not thoroughly understanding the wants and tastes of the people with whom trade is to be established.

In arranging the samples of this museum, a portion of the building is devoted to each category of products from all countries, and these are so classified that a visitor can at once see not only the origin of each specimen, but with the aid of a catalogue, gratuitously furnished, may also study its industrial value or adaptability to the markets he desires to reach. In addition to the information furnished in the catalogue referred to, there is also a "bureau of information," for the purpose of answering all inquiries, and explaining such additional facts as the government may possess relating to the origin, character, and practical purpose of each sample, with the cost of its production, and all other items relating to its commercial value. Another of the functions of this bureau is to procure, for the information of all concerned, plans and specifications of all proposed public improvements, either foreign or domestic, that may be yet open to a competition for contract, with a list of the awards of such contracts as have already been made, including the terms and conditions of the same. Desks, tables, and writing material are also provided for the convenience of visitors who may wish to avail themselves of them in taking note of any of the contents of the sample department.

There is also attached to the museum a library composed of technical works on the principal industries of the world, dictionaries of technology, catalogues of museums of art and manufacture, foreign journals of manufacture and commerce, and especially such as contain notices of proposed contracts for all kinds of material and labor products.

Another department, denominated the *Indicateur*, contains the special archives of the museum. No outside correspondence is permitted directly with this bureau, and all communications intended for it must be first inscribed at the ministry of foreign affairs, after which they are sent to the museum by the chief clerk of the department of commerce and consulates. Documents issuing from this bureau must be signed and submitted for the approbation of the chief secretary of the department of state, and then forwarded to the minister of foreign affairs for his approval. All documents furnishing information in regard to the articles on exposition in the museum are regularly filed and numbered with a special number, so that by consulting the catalogue and the number of the document any article may at once be found by persons desiring to examine it and know its commercial value. A weekly journal is published in connection with the museum, devoted to practical information in the department of commerce and industry, gleaned from foreign sources by the consuls and other foreign agents of the government.

The public is admitted, without fee, every day except Sunday, from half-past nine in the morning until four in the afternoon, and any person wishing special information, not obtainable from the samples, by signifying to the doorkeeper his desire to consult the bureau of information, is at once admitted, and the information given him, if possible, without question.

A capacious and costly building has been appropriated to this purpose by the government, and already a large number of specimens are arranged for exhibition; but it is intended so to extend this sample department as to embrace not only specimens of foreign manufactures, but every kind of foreign crude or raw material capable of being converted into manufactured products by the industrial establishment of Belgium. There is also in this building a very important department called the "packing and finishing room." Under the just impression that the manner in which merchandise is packed, labeled, and otherwise prepared for the markets has much to do with the recommendation, the government has devoted these rooms to the study of this art in all its details. It is intended to here exhibit the finest specimens of packing and the most attractively prepared merchandise, both foreign and domestic, so that all concerned may see what importance Dame Commerce attaches to the fine dress of her wares. This is a most important branch of the instruction proposed to be imparted by this establishment, and will doubtless correct much of that flimsy and awkward packing of goods for foreign markets now so common in this country.

In announcing the object of the museum, the government claim that as a producing country Belgium has nothing to fear from the competition of any foreign country, either as to the quality of her manufactures, or the price of her soil products, but declares that in order to secure her legitimate degree of commercial success in distant foreign countries two things are absolutely necessary, the first of which is to free herself of her dependence on the other great commercial states that surround her, and sell her merchandise in foreign markets as their own, thus depriving her manufacturers of the profits of direct sales to the consumers; and the second is to better conform the manufacture of her merchandise to the tastes and wants of foreign markets.

While admitting the difficulty to be encountered in accomplishing the first mentioned of these objects, it feels assured of the practicability of the other, and to this end it now proposes seriously to set to work. It has given orders to all its consuls and other foreign agents to collect from every part of the world where they may be located samples of such manufactures as are most in use there—to ascertain the styles and patterns most esteemed, and to send them home to this museum, that the Belgian manufacturer may see and know for himself how he may more successfully compete for this trade.

These officers are especially enjoined to send home specimens of metallic ores, textile matter, and, indeed, all such other raw material as may in any way be capable of being converted into useful products, that the genius of the Belgian manufacturers may be thus stimulated to a more diversified product. In short, the government proposes to make this museum a great industrial educator; and from the thorough manner in which it has been organized, and the liberal and methodical policy by which it will be administered, I doubt not that it will be a success in at least enabling the manufacturer to adapt his wares to the markets he wishes to reach, and in opening up new and direct commercial relations with distant countries which his merchandise has heretofore only reached as English, French, or German goods.

Whether a museum of this character would greatly contribute to the foreign sale of our manufactures I will not venture to say; but I am very certain that this trade could be greatly increased if our manufacturers and merchants, instead of attempting to force on foreign people the styles and fashions in vogue with us, would recognize the force of immemorial habit and the local peculiarities and prejudices of foreign people, and better adapt their merchandise to them.

As an illustration of what is meant, I will only mention the articles of locks, hinges, and window and door fastenings. No people in the world make these articles of so fine patterns and quality as we do, but unhappily for our manufacturers the social system, if not the climate, of almost the whole of this continent has led to the adoption of certain styles of doors and windows, as well as their fastenings, for which our locks, hinges, and fastenings are not suited; and therefore, however superior ours may be in both design and quality they cannot be sold in any quantity. This is probably a strong case, seeing that it involves features of social life hard to change, and also a style of manufacture repugnant to our tastes, but there certainly are many of our manufactures now almost excluded from European markets which we could doubtless profitably sell if we would better adapt them to the tastes and prejudices, if not the wants, of these people.

Brussels, July 11, 1882.

A VISIT TO THE TUILERIES.

Visitors to Paris will in a few years seek in vain for the ruins of the Tuileries, built on the plain of the Sablonnières, and deriving its name from the tile kilns which surrounded the house of the Sire de Villeroy, pulled down afterward to make way for the château Catharine de Medicis, built when she refused to reside within the precincts of the old Louvre. Guide-books and historians will tell the tale of the Tuileries. Ciceroni will point to the secret passage which leads to the Place de la Concorde and served to protect the flight of Louis Philippe and the Empress Eugénie. M. Francisque Sarcey will be able to tell future generations all about the palace where the guests of the Empire had met, where many a stirring incident had taken place, and the chronicles of which have been handed down in the secret memoirs of Merimée, which are to be published shortly. The history of King, Emperor, and people is under the charred ruins, which are to be carted away. There is the picture painted by Meissonnier, limned *con amore*, which is to be hung up in the museum the City of Paris will erect on the site of the Tuileries. The painting will recall the ruins, and show the tumbling walls of the chapel, which was used as a place of meeting by the members of the Convention, and where the Dread Committee of Public Safety held its assizes. Louis XVI. left the Tuileries to go to the Temple, and he was guillotined in front of the Palace on the Place de la Revolution. Robespierre, with his jaw all bleeding, was taken to the Tuileries before he was pursued to the scaffold amid the shouts of execration of those who dreaded him when he was all powerful. Architects have examined the walls of the Tuileries, and have arrived at the conclusion that the whole of the building must come down, and as the people do not care to rebuild a new palace, the idea put forward by Janin in 1880 will be carried out, and a museum will hide from future visitors to Paris the blackened stone which attests the horrors of a civil war.

Offers have been made to the Government for the disposal of the ruins of the Tuileries. Certain sanguine speculators proposed to form companies for the purpose of excavating and discovering the treasures they felt certain were hidden. An Englishman wanted to pull down the building at his own cost, without any expense to the Government, on condition that he might be allowed to dispose as he liked of the materials and anything he might find. This proposition was declined, and the promoters think that the refusal of the stranger's offer confirms the opinion they have entertained as to the secret treasures. M. Sardou is to have some of the marble columns from the Salle des Maréchaux, and M. Picart, the Government contractor, promises that he will not have to wait too long. Before M. Picart commences his work of destruction, it is well for those who can boast of friends at court to visit for an hour or two the ruins where, during twenty long years of prosperity to France, the Empire was installed; where Napoleon III. dispensed his favors to all who had the slightest claim on him, and where the Empress was worshiped by all who knew her. Care has to be taken in visiting the ruins, as the least vibration, such as that produced by a cart passing along the street, is quite enough to unsettle some portion of the charred stone-work, while the stairs leading from one part of the building to another are not oversafe. Entering by the principal door facing the Champs Elysées, the work of destruction appears to be complete. There are heaps and heaps of *débris*, charred marble, iron twisted and warped with the heat, pieces of looking-glass half liquefied by the action of the flames, portions of some of the statues which formerly ornamented the palace—in fact, odds and ends of every description, including old boots and shoes worn, or rather cast off, by the precious scoundrels who formed the armed bands of the Commune and commenced the work of destruction by firing the Tuileries.

The grand house is in ruins; the least movement from the birds which quit their nests and fly out at the approach of any stranger brings down a shower of plaster and stones. The ground is covered with rank weeds knee-high, with here and there some bush, which has grown out defiantly from among the ill-smelling vegetation. The mouldings on some of the ceilings are hardly scorched by the flames, but the walls and windows have been charred and well-nigh consumed. The chapel where the Convocation met is burned out, and care has to be taken in treading the flooring, which almost threatens to precipitate the visitor into some *oubliette*. The colonnade of the chapel is intact, as also the iron and marble staircase of the main building leading to the vast Salle des Maréchaux. The bronze and ormolu balustrading has been destroyed, and the long trains of court dames would hardly look well sweeping over the thick dust which has accumulated nearly a foot deep on the grand staircase. Here and there the last tenants of the Tuileries—the mob of Communists, who delighted to hold their saturnalia in the palace of King and Emperor—have written up obscene remarks or galling allusions to the fallen *régime*, proving by their orthography that those who attempted to inaugurate a second Age of Reason had commenced by banishing the school-master. The word "Badinguet," the name of the bricklayer whose place Louis Napoleon took when he made his escape from the fort of Ham, is to be found frequently on the walls with the famous inscription, "*Mort aux voleurs*," which might have been further embellished with the proviso "when caught." There is the grand banquet hall where most of the reigning sovereigns who visited Paris during the great exhibition were received by the Emperor. The handsome gilt columns have not been much damaged, but the flooring cracks and yields under the feet of the visitor, and the marble bust of the Emperor, which once adorned the niche, lies shattered on the floor. The Salle des Maréchaux has suffered greatly from the fire. The place where Mme. Agar stood and declaimed, swathed in the blood-red banner of the Commune, "La Marseillaise," is in ruins.

The names of the victories achieved by the Napoleons can still be read in the vast room where, on the 15th of August each year, Napoleon III., surrounded by his marshals, received the homage of the army, and where the legend of the Legion of Honor, "*Honneur et Patrie*," was emblazoned in letters of gold on the walls, sorrounded by such glorious souvenirs as "Jena," "Marengo," etc. The flames have worked ruin in the private apartments of the Empress, but the ceiling in the boudoir where Mme. De Galiffet, with the Princess de Sargan and others, met to discuss some new fashion with the imperial leader of *ton*, has remained intact. The private departments of the Emperor have been spared. They have been boarded up to prevent the incursions of those who wander at nights, and a long detour has to be made to reach the balcony where the last of the Napoleons sat and smoked his legendary cigarette, watching the setting sun gild the dome of the Invalides, where the great captain lies sleeping his last sleep on the banks of the Seine, in the midst of a people the page of whose story, the brightest or blackest, was filled with his fame. There is the lobby and the ante-chamber, where Marshal St. Arnaud drew his sword on his companion, Gen. Cornemuse, and killed him, and there is the study where the third Napoleon sat looking over the proof-sheets of the "Life of Cæsar," or reading listlessly the prophetic poetry of the man he called "Monsieur" Victor Hugo, and whose "Châtiments" made him the Josephus of the Commune. The visitor cannot help pausing from time to time to reflect over the past. Each piece of marble disturbed by the foot brings to mind mournful reminiscences. The history of the Third Empire is written in the dust which lies on the ground, and may be built up from the fragments of busts which are scattered here and there, and as if all the king's horses and all the king's men could never put together the pieces of that empire which sank into the dust of Sedan.—*London Globe.*

JAPANESE GOLD LACQUER WORK.

A report has been prepared by Mr. J. J. Quin, British Acting Consul at Hakodate, on the lacquer industry of Japan. It is intended chiefly as a description to accompany a collection of illustrative specimens, tools, and products at the Economic Museum at Kew. The cultivation of the lacquer-tree and the manufacture of the various kinds of lacquer is described, the woods used for the production of lacquer ware, and the various processes of lacquering, from the ordinary plain work to the treatment of gold lacquer. In drawing up the report it was found that a number of Japanese terms had to be employed which necessitated a somewhat detailed explanation, so as to be intelligible to any one not acquainted with the language, and not familiar with the technicalities of the trade. The following extracts on the gold lacquer work, describing the mode of treatment, may be of interest:

Mode of making Gold Lacquer.—A description is given first of *Togi-dashi* (bringing out by polishing). The article having been already subjected to twenty-two processes of ordinary lacquering, is then treated as follows The picture to be transferred to the article is drawn on thin paper, to which a coating of size made of glue and alum has been applied—that known as *Mino-gami* is best. The reverse is rubbed smooth with a polished shell or pebble, and the outline very lightly traced in lacquer, previously roasted over live charcoal to prevent its drying, with a fine brush made of rat's hair. The paper is then laid, with the lacquer side downward, on the article to be decorated, and is gently rubbed with a whalebone spatula wherever there is any tracing, and on removing the paper the impress may very faintly be perceived. To bring it out plainly it is rubbed over very lightly with a piece of cotton wool, charged with powdered white whetstone or tin, which adheres to the lacquer. Japanese paper being peculiarly tough, upward of twenty impressions can be taken off from one tracing, and when that is no longer possible, from the lacquer having become used up, it only requires a fresh tracing over the same paper to reproduce the design *ad infinitum*. This tracing does not dry, owing to the lacquer used for the purpose having been partially roasted, as previously mentioned, and can be wiped off at any time.

The next process is to trace out the veining of the leaves, or such lines to which in the finished picture it is desired to give the most prominence, and these lines are powdered over with gold dust through a quill. The qualities called *Mijin*, *Koma-kame-mijin*, and *Aragoku*, are generally used; either finer or coarser qualities cannot be used. The article is then set to dry for twenty-four hours in the damp press. The outline is now drawn carefully with a rat's hair brush over the original tracing line with a mixture of black and branch lacquer, called *Rō-sé*. The whole is then filled in with *Rō-sé* applied with a hare's hair grounding brush. Gold dust of a slightly coarser quality than *Mijin* is scattered over the lacquered portion, and the article is set to dry for twenty-four hours. Another thin coating of *Rō sé* lacquer is again given to the gold-powdered portions, and the article set to dry for twelve hours. Next, a coat of *Rō* (black lacquer) is applied over the whole surface of the article, which is set to dry for at least three days. It is then roughly ground down with *Magnolia* charcoal, the surface dust being constantly wiped off with a damp cloth till the pattern begins to appear faintly. Another coating of *Ro* lacquer is then given, and the article set to dry for thirty-six hours. It is again ground down with *Magnolia* charcoal as before, this time till the pattern comes well out. The ensuing processes are the same as described in black lacquer.

In making *Togi-dashi* on hard woods, transparent lacquer is used instead of *Ro*.

Flat Gold Lacquer.—For this method, called *Hira-makiye*, the article having been thoroughly finished, either in black

or red, etc., a tracing is applied to the surface as in *Togi-dashi*. the outline is carefully painted over with a fine brush of rat's hair and then filled in with a hare's hair brush, using *Shitamaki* lacquer (branch lacquer and red oxide of iron). Over this surface, gold dust, of the quality called *Aragoku*, being generally used, is scattered with a brush of horse's hair (*Kebo*) till the lacquer will not absord any more. The article is then set to dry for twenty four hours. A thin coating is next applied over the gold, of transparent lacquer, or *Yoshino* lacquer, and set to dry for twenty-four hours at least. It is then most carefully smoothed with camellia charcoal, and finally polished off with *Tono ko* and a little oil on the point of the finger, till the ornamented portion attains a fine polish. The veining of leaves and the painting of stamens, etc., of flowers, or such other fine work, is now done with a fine rat's hair brush charged with *Ke-uchi* lacquer, over which fine gold dust (*Goku-mijin*) is scattered from a brush of horse's hair (*Kebo*) as before, and the article set to dry for twelve hours. Some *Yoshino* lacquer is then applied to a piece of cotton wool, and rubbed over the whole surface of the box or other article, and wiped off again with soft paper. It is set to dry for twelve hours, after which it is polished off with deer's horn ashes and a trifle of oil. When very high-class work is desired, *Yoshino* lacquer, to which a little water has been added, is applied, and polished off a second time, and a very brilliant surface is attained.

More ordinary "flat gold lacquer" differs in the manufacture, as follows: The tracing is accomplished in the same manner, but *Shit-maki-nobe* lacquer (branch lacquer, red oxide of iron, and camphor), is used for filling in the pattern with a hare's hair brush. The article is then set to dry in the press for ten to twenty minutes, during which time the lacquer has begun to harden, and less gold will adhere. Then gold dust (*Goku-mijin*) is applied with cotton wool thinly, and the article is set to dry for twenty-four hours. The whole surface is then smeared over with *Yoshino-nobe* lacquer (*Yoshino* lacquer and camphor) on a piece of cotton wool, and wiped off again with soft paper. The reason is that it is less trouble to smear over the whole surface thinly, and it is, moreover, not necessary to give a thick coat of lacquer to the decorated part, as the gold dust has been very thinly applied. It is set to dry for twelve hours, and ground smooth with camellia charcoal, and polished with powdered whetstone and oil on the point of the finger. The fine lines are then drawn with a rat's hair brush charged with *Shitamaki* lacquer, and sprinkled with gold dust (*Goku-mijin*) from a brush (*Keto*), and the article set to dry for twelve hours. The whole is again smeared with *Yoshino-nobe* lacquer, and carefully wiped off again with paper, and set to dry for twelve hours. The article is then polished with powdered whetstone and oil on the point of the finger, and a second application of *Yoshino-nobe* lacquer with a little water, wiped off with soft paper, set to dry for twelve hours, and finally polished off with deer's horn ashes and oil on the finger, finishes the operation.

Should it be required to make any dark spots or lines, such as birds' eyes, or to draw human hair, etc., or other shading, this is done last of all with *Kuma*, "bear" lacquer, and *Jo-hana*, and lampblack.

For a more common kind of flat gold lacquer painting, instead of tracing the design in roasted lacquer, it is done with a mixture of powdered *Tono-ko* (burnt clay from Mount Mari) and water, and the impression is transferred to the articles with the whalebone spatula as before. The reason for only using *Tono-ko* instead of lacquer is that the groundwork being inferior it cannot be ground or smoothed afterward, and the edges of the pattern would not be clean, nor stand out clear, should any lacquer get smeared outside the tracing line. The outline is then filled in with *Shitamaki-nobe* lacquer with a coarse hare's hair brush, and the article is set to dry for twenty minutes, or till a thin skin has formed on the lacquer, and then the half-dry surface is wiped over with cotton wool charged with *Keshi-fun*, the finest gold powder, and set to dry for five or six hours. The whole surface is then smeared with *Yoshino-nobe* lacquer, which is carefully wiped off again with soft paper, and the article set to dry for half a day. The surface is then rubbed over gently with deer's horn ashes and soft paper to give it a polish, and to get rid of any of the last coat of *Yoshino-nobe* lacquer.

The fine lines are now drawn with a fine hare's hair brush charged with *Shitamaki nobe* lacquer, and the article set to dry for twenty minutes or so; then *Keshi-fun* is applied with cotton wool, and again set to dry for five or six hours. No further process takes place.

Raised Gold Lacquer.—In the method *Taka-makiye* the groundwork may be either black or colored lacquer, *Nashiji* (pear basis of gold dust), or the plain wood. The outlines of the pattern are transferred to the surface of the article in the same manner as in *Togi-dashi*, or "flat lacquer." The outline is then painted over with *Shitamaki* lacquer, and this is covered with powdered camellia charcoal. If the outside is to be higher than the inside, a broad margin is painted and covered with the charcoal powder, leaving the center untouched, and *vice versa;* if the center is to be higher a faint line only is painted outside, and the inside is given a thickish coating, which is sprinkled with the charcoal dust, and the article set to dry for twelve hours. When taken out of the press it is well dusted to get rid of any loose charcoal powder, and is also washed, using a brush made of human hair (*Hake*) to clean out all crevices and bring out the lines, etc. Some *Yoshino-nobe*, or "branch lacquer," with camphor, is now rubbed on with a piece of cotton wool and carefully wiped off with soft paper, and the article set to dry for twelve hours. The raised parts are next carefully ground smooth with a piece of *Magnolia* charcoal, and a second coat of *Yoshino nobe*, or of "branch lacquer," is applied as before and dried.

[If a well-raised pattern is required, one, two, or even three coats of *Sabi* ("branch lacquer" and *Tono-ko*) are applied, the outside edges being painted with a brush of deer's hair (*Menso*), and the inside lacquer applied with a small *Sabi* spatula, the article being set to dry between each application for twelve hours. For coarser work it is then ground smooth with a white whetstone, and for finer work with a yellow whetstone. Over this some "branch lacquer," mixed with camphor, is rubbed with cotton wool and wiped off with soft paper, and the article set to dry for twelve hours.]

If the pattern is not to be very high the operations described between the brackets are omitted. A coating of *Takamaki* lacquer is now given, the outside edges being carefully drawn with a rat's hair brush, and the inside of the pattern filled in with a hare's hair brush, and the article set to dry for thirty-six to forty-eight hours. When taken out of the press the surface is ground smooth with *Magnolia* charcoal, and then partly polished with powdered camellia charcoal on a cotton cloth. A little oil is now rubbed on, and a further polishing takes place with powdered "whetstone" on a cloth. Next "branch lacquer" is rubbed over the raised parts with cotton wool and wiped off with soft paper, and the article set to dry for twelve hours. It is next polished with deer's horn ashes and a little "rape seed," or "sesamum" oil applied on the point of the finger. Up to this point the formation of the pattern, whether mountains, waves, trees, men, birds, or animals, has been gradually completed.

If small squares of gold foil (known as *Kiri kane*), or of colored shell, are used in producing the pattern. they are now applied one by one on the point of a bamboo stick (*Hirame fude*), the spot where they are to be affixed having been smeared with a little *Ro-sé* lacquer to make them adhere. When all that is required has been affixed, a piece of soft bibulous paper is spread over the freshly done parts and pressed very carefully with the finger. This is to get rid of as much of the *Ro-sé* lacquer as is not covered by the gold squares as possible; the article is set to dry for twelve hours, and then the portion where the gold has been applied is gently polished with a little camellia charcoal on the point of the finger, to get rid of the remainder of the *Ro-sé* lacquer. Shell patterns, and the coarser kinds of gold dust that may be required, are applied in the same manner. The finer kinds of gold dust are applied next, over a coat of *Shitamaki* lacquer, and the article set to dry for twelve hours. The remaining processes of polishing, drying, etc., are the same as in first-class "flat gold" lacquer.

For making raised lacquer patterns on plain wood the whole surface is covered with tin foil, stuck on with rice paste, to keep the wood quite clean, and then the place only where the pattern is to come is cut out. In making all high-class lacquer the edges of every article are pasted over with tin foil to prevent their being rubbed or injured by the workman, and the same is done over each portion as it is finished.

The above is the ordinary method of making best raised lacquer, but there are such innumerable modifications of one process or another, according to the object to be produced, that it is manifestly impossible to do more than give the above cursory sketch. Nearly every piece of good lacquer made exhibits a specimen of each kind, viz., *Nashiji*, *Togi-dashi*, *Hira-makiye*, or *Taka-makiye*.

In making raised lacquer on inferior articles the methods do not vary much from the good kinds; the work is merely less carefully executed. The saving is in the quantity and quality of the gold dust used, and the absence of minute after-work, or in the use of silver and tin instead of gold dust. In the very cheapest kinds burnt tin dust is used instead of charcoal over the first coat of *Shitamaki*. This is burnished bright, and over it a thin coating of lacquer and gold dust is applied. At first it looks well, but loses its color in a year or two. By using tin powder the same height is attained in one coat that would necessitate at least three coats of lacquer and charcoal dust. This kind of work is, however, only used for cheap articles for foreign export, and has been quite lately introduced.

Lacquering on Metal.—For lacquering on iron or copper, brass or silver, the metal is smoothed and polished, and then given a coating of "crude lacquer" or "black lacquer;" the article is put over a charcoal fire, and the lacquer is burnt on to the metal till all the smoke ceases to escape. The fire must not be too fierce, and the metal must not be allowed to get red-hot, or the lacquer turns to ashes. After the lacquer has burnt quite hard the surface is rubbed smooth with *Lagerstrœmia* charcoal; these operations are repeated three or four times, till a good foundation of lacquer has been obtained. Then the same operations exactly are repeated as in making best "black lacquer," *Togi-dashi*, "flat gold lacquer," or "raised gold lacquer," only that the lacquer is burnt dry over the fire instead of being dried in the press. The lacquer is thus rendered quite hard and very durable. After the first two or three coats have been burnt on, the subsequent drying processes can be carried on in the damp press, should it be so desired.

In winter, or when any article is required in a hurry, the workmen sometimes put a charcoal fire in the press, over which a pan of hot water is placed. The steam which is thus generated helps to dry the lacquer in an hour or two, which would take twenty-four hours to harden ordinarily, but the lacquer thus dealt with loses its strength, and is never very hard. "Black lacquer" turns a rusty brown, the coloring virtue of the iron being apparently lost, and therefore this plan in never adopted for good work, and in second-rate work only for under coats.

The style of ornamentation, *Nashiji*, occupying an intermediate position between plain and ornamental lacquer, is therefore treated of last. Till the opening of Japan to foreign trade it was in the hands of workers in gold lacquer, but now for the most part all *Nashiji* on articles intended for exportation is applied by the workers in plain lacquer. In making best *Nashiji* as in *Togi-dashi*, the first twenty-two processes are identical. A coating of *Ro-sé* is applied, and the gold dust is sprinkled over this surface through one or other of the bamboo tubes, according to the fineness required. The article is set to dry in the press for forty-eight hours, and is then given a coating of pure transparent varnish. This is set to dry for three or four days, when it is roughly ground with *Magnolia* charcoal, and a second coat of transparent lacquer given. The article is set to dry for forty-eight hours, and then ground with *Magnolia* charcoal till a perfectly smooth surface is obtained. Transparent lacquer is then applied with a piece of cotton wool, and wiped off again with soft paper, and the article set to dry for twenty-four hours. It is then polished with a mixture of *Tono-ko* and camellia charcoal powder and a little oil. Next, a coating of *Yoshino* lacquer is given, and wiped off with paper; the article is set to dry for twelve hours, and then it is polished with deer's horn ashes and oil. This is repeated three times to finish the article.

The same processes are gone through when using silver instead of gold dust. For cheap qualities tin dust is used, and the powder is scattered on glue immediately above a coating of *Kanoji* (whiting and glue). When the article is dry it is burnished with *Tokusa* (*Equisetum*), and as soon as it presents a bright surface a coating of pure transparent lacquer, with gamboge, is given to it. It is set to dry for a day in the press, and then ground with *Magnolia* charcoal. Over this a coating of *Shu-urushi* (transparent varnish containing oil) is applied, and another drying for twenty-four hours completes the process.

WHOOPING COUGH.—Dr. Aymerick, in the *Medical Press and Circular*, recommends, in the treatment of whooping-cough, the employment of phenic acid with bromide of potassium: bromide of potassium, one drachm; phenic acid, three to four grains; sirup lemons, q. s.; vehicle, six ounces. A large or a small spoonful, according to the age of the patient, every two hours. He has never seen any accident to follow the antiseptic method.

ARTIFICIAL STONE.

MANY kinds of material have been used for the production of artificial stone. That which has been used on the largest scale, and, until a comparatively recent period, exclusively, was cemented by a calcareous substance, as Roman, or still better, Portland cement, which hardens after being mixed with water. Ordinary concrete and beton are of this class. Terra cotta, employed for architectural ornaments, statuary, etc., is in the nature of a fine brick.

Cement stones have been largely employed for constructions in the sea, especially for harbor dams, breakwaters, and quay walling. We may cite the moles of Dover and Alderney, in England; of Port Vendre, Cette, La Ciotat, Marseilles, and Cherbourg, in France; Carthagena in Spain, Pola in the Adriatic, of Algiers and Port Said in Africa, and Cape Henlopen at the mouth of the Delaware. For the breakwater at Cherbourg artificial stone blocks of 712 cubic feet each were immersed.

The fortifications before Copenhagen are made of a concrete of broken stone and hydraulic mortar. The sluice of Francis Joseph on the Danube, in Hungary, is built entirely of concrete. This work forms a reservoir, the bottom and sides of which consist of one piece. Its length is 360 feet and width 30 feet. Its construction began in 1854, was completed within ninety days, the work being pushed forward both day and night.

M. Coignet's *beton agglomere* was used in the erection of the aqueduct of La Vanne, in the department of the Aube, and of the Yonne to the city of Paris. The distance from Paris to La Vanne is over 135 miles. The section which traverses the forest of Fontainebleau comprises three miles of arches, some of them as much as 50 feet in height, and 11 miles of tunnels, nearly all constructed of the material excavated on the spot. The monolithic test arch at St. Denis, Paris, has a span of 196 feet and an elevation of 19 feet.

Coignet's beton is compounded of sand 5, lime 1, and say 25 of hydraulic cement. mixed with an unusually small quantity of water, considerable mechanical exertion, followed by heavy ramming when the concrete is placed in the mould. The reduction of the volume by ramming is 1·7 to 1, and the weight of a cubic foot becomes 140 pounds. The blocks soon harden in the air, and the resistance to compression is 5,000 pounds to the square inch. An ordinary mortar of the same material will be crushed by a pressure of 500 pounds.

Recent French inventions in this line embrace: Compacting the particles of which the stone is formed together by the action of a rammer upon successive layers while in a plastic state; forming monolithic buildings of a stone paste, the heating and ventilating flues and also the gas and water pipes being formed within the mass by the introduction of cores, which are afterward withdrawn; a modification of this for wharves, dams, abutment walls, etc., consists in making the walls hollow or honey-combed, and filling in the spaces or cells with earth or other cheap material; iron scraps may be incorporated with the material to bind it together, or a skeleton metallic frame-work may be embedded in the walls while being made.

Orsi's artificial lava consists of stone or gravel 48, pulverized chalk 32, tar 16, wax 1. The solid ingredients are added to the melted tar and wax and the mixture poured into moulds.

Metallic lava consists of ground flint 2, broken marble 3, resin 1, with small quantities of wax and coloring matter to imitate stone. It is used for tessellated pavements, the slabs being backed with concrete.

Artificial stone, having silica as the cementing material, was first introduced by Ransome. He originally made this stone by boiling flints, under a pressure of about 60 pounds to the inch, in a solution of soda, to which lime was added to render it caustic. The soluble glass thus obtained, about the consistency of treacle, was mixed in the proportion of about 1 part to 10 of sand, 1 powdered flint, 1 clay; forming a paste which was moulded into blocks, afterward dried in a steam bath to prevent the formation of a coating of silicate on the outside, which would prevent the escape of the vapor from the interior, and afterward burned in a kiln.

As at present made, the stone consists of clean sand and silicate of lime. It resists boiling, roasting, freezing, pickling in acids, fumigating with gases, soaking, heating to redness, and plunging into ice water.

Flints are digested by boiling in a caustic solution of soda under pressure, giving a silicate of soda. This is added at the rate of one gallon to each bushel of well dried sand, whose interstices are partially filled with dust of carbonate of lime After careful mixing, the plastic mass is rammed and moulded. The block is immersed in a solution of chloride of calcium. A reaction takes place; the silicate of soda and the chloride of calcium mutually decompose each other and reunite as silicate of lime and chloride of sodium, the former practically indestructible in air, the latter, common salt, perfectly deliquescent and removable by washing, although the stone, after the washing, is impermeable to water.

The tensile strength of this, by experiment, was, for a piece 2¼ bore, from 870 to 1,200 pounds crushing strength, cubes of 4 inches square, 44 to 48 tons. It has been used for grindstones with excellent effect. The same process forms the basis of several United States patents.

A "silicious varnish" was used to give sharpness and permanency to the tri-lingual cruciform inscription on the scarp of a limestone mountain at Behistun, on the Tigris. It has been partially detached by the action of the elements during 23 centuries, and lies in scales at the foot of the precipice. It was cut by the orders of Darius Hystaspes, about 516 B. C., to celebrate a victory over the Magians. We are indebted to Rawlinson for the deciphering of the inscription.

In Sorel's process, natural magnesite—carbonate of magnesia—is first calcined, which reduces it to the oxide of magnesium. In this state it is mixed dry in the proper proportion, by weight, with the powdered marble, quartz, sand, or whatever material forms the basis of the stone. It is then wetted with bittern water, which converts the oxide of magnesium into oxychloride The now semi-plastic mixture is rammed into moulds, when it speedily hardens, sufficiently to be taken out and laid on skids. In two hours' time the stomach will resist rain, and in two weeks the stones may be used.

A patent, issued in 1875, proposes to render artificial stone impervious to moisture and to prevent efflorescence thereon by mixing with the ordinary constituents, in the process of manufacture, soluble, earthy, or metallic sulphates in the form of a powder, and then a solution of the fatty acids.

McMurtrie and Chambers treat the surface of the stone with a solution of earthy or metallic sulphates, and then with a solution of the fatty acids.—*Pottery and Glassware Reporter.*

SUNLIGHT AND SKYLIGHT AT HIGH ALTITUDES.*

By CAPTAIN W. DE W. ABNEY, R.E., F.R.S.

DURING the end of June and beginning of July the author paid a visit to the Riffel, above Zermatt, which is at an altitude of about 8,500 feet, in order to study spectroscopically solar light. The air there is very dry, the wet and the dry bulb sometimes reading a difference of 7° or 8°, the wet bulb being near by 32°. The author was much struck with the exceedingly black blue sky which was apparent at this altitude, and during his researches he carried on also an examination of the light from this blue sky composing it. The spectroscope, combined with photography, showed that the sky spectrum was very feeble compared with that of the sky in England, the maximum of intensity lying near H in the extreme violet, while in the latter case it was somewhere near G. The intensity of this violet band was only about one-fifth, and the total photographic effect was somewhere about one-twentieth of that found in an English blue sky. In observations of direct sunlight the total photographic effect on silver bromide was, probably, doubled, owing to the enormous increase in the ultra-violet rays. These rays, usually so invisible, could be viewed for a long way up the spectrum, showing that with sufficient intensity the eye is sensitive to this class of radiation. These observations show the difficulty that photographers at this altitude meet with in securing good pictures. The highest lights have double the brilliancy, and the deep shadows only one-tenth the illumination, of the same objects when photographed from below, always supposing that the principal part of the illumination of the shadows comes from the sky. The author then traced this blueness of the sky and the increase in the ultra-violet of the direct sunlight to absence of "water stuff," and dust left below in the bottom one-third of the atmosphere which existed below 8,500 feet. Observations at the zenith and horizon, both at high and low altitudes, were undertaken to confirm or disprove the above statements. Another confirmation was that, although the rain-band was often visible at Zermatt, 3,000 feet below, yet it was never visible at the Riffel except when rain was absolutely falling. The examination of the intra-red region of the spectrum showed that none of the absorption lines could be traced to atmospheric causes, and that they must be due to matters either in the sun itself or between our atmosphere and the sun. In the case of the benzine and alcohol, which were shown to be present, the probability was that they were in space, since their traces had not been found in the solar spectrum during the recent eclipse. The effect of moisture in the atmosphere apparently is the same as if a solar spectrum in dry air were photographed. I had from three inches to two feet of pure water. No increase of lines is found, but only the shaded bands which are found in the absorption spectra of water. The author also made some remarks on the A and B lines, which were certainly not due to atmospheric causes, but must be located in the sun or in space—in which he did not say.

The chairman observed that those who doubted the diffusion of alcohol throughout the universe might be glad of an opportunity to refute it.

Mr. J. Glaisher said he had never failed up to five miles in getting a deposition of vapor, and there was no part of the earth's atmosphere probably in which there was no aqueous vapor. At a height of seven miles in a balloon he had seen cirrus clouds still higher, and there was a great difference between the state of the atmosphere in a free balloon and on a mountain side.

DETECTION OF FUSEL OIL.

FUSEL oil consists chiefly of amylic alcohol, and although the latter differs very much in taste, smell, and physiological properties from ordinary alcohol, its presence in small quantities in brandy, whisky, etc., is not easily detected; the estimation of the quantity present was scarcely possible. L. Marquardt, of Hamburg, believes that he has solved this problem. Without entering into the details of the quantitative analysis, which is exceedingly tedious, we will only say that his process consists in first extracting the fusel oil with chloroform, washing thoroughly, and then oxidizing the amylic alcohol to valerianic acid by means of bichromate of potash and strong sulphuric acid at 185° F. The odor of the acid is easily recognized.

ON A SUPPOSED CONNECTION BETWEEN THE HEIGHTS OF RIVERS AND THE NUMBER OF SUNSPOTS ON THE SUN.

By PROF. BALFOUR STEWART, M.A., LL.D., F.R.S.

WHILE a connection between the state of the sun's surface as regards spots, and the magnetic state of the earth, may be considered as well established, the fact of a connection between sunspots and terrestrial meteorology is still *sub judice*, and without attempting to assert the truth of such a connection, the following may perhaps be regarded as a slight contribution tending to throw light upon the subject. The heights of the rivers Elbe and Seine have already been examined by Fritz, who reported in favor of such a connection as would make a great height correspond to a large number of sunspots, and all that I have done has been to treat the evidence in a somewhat different manner. I divide each sun period without regard to its exact length into twelve portions, and put together the recorded river heights, corresponding in time to similar portions of consecutive sun-periods. I find by this means residual differences from the average, representing the same law whether we take the whole, or either half of all the recorded observations, and whether we take the Elbe or the Seine. This law is that there is a maximum of river height about the time of maximum sunspots, and another subsidiary maximum about the time of minimum sunspots. It is of interest to know whether the same behavior is followed by the River Nile. Through the kindness of General Stone Pacha, and through the Science and Art Department, South Kensington, information has been obtained about this river. This information shows us that the Nile agrees with the European rivers in exhibiting a maximum about the times of maximum sunspots and a subsidiary maximum about the time of minimum sunspots, only the subsidiary maximum is greater than for the European rivers already named. It also appears that the date of maximum height of the Nile is latest on these years for which the yearly height is greatest. Now the present year is, perhaps, not very far removed from a solar maximum, and I am thus induced to think that the Nile may this year be somewhat late in attaining its maximum rise.

* Abstract from a paper before the British Association.

PRESENTATION OF A MEDAL TO M. PASTEUR.

THE wonderful discoveries made by M. Pasteur have for a long time past placed him in the front rank of science, which he continues to serve with the greatest *éclat*. A committee composed of members of the Academy of Sciences, of the Academy of Medicine, of the Society of Agriculture, of the Faculty of Medicine and higher Normal School, was not long since formed, under the presidency of M. Dumas, with a view of offering him a medal commemorative of his many works. The execution of the medal was intrusted to M. Alph. Dubois. On the 25th of June, Messrs. Dumas, Boussingault, Jamin, Bouley, and Daubrée, members of the Institute; Bertin, Director of Studies at the Normal School; Davaine and Villemin, members of the Academy of Medicine; and Tisserand, Director of Agriculture and Commerce, proceeded to the laboratory of M. Pasteur, where they found him surrounded by the members of his family. The medal was presented to the distinguished investigator, with appropriate remarks, by M. Dumas.

We give herewith, from *La Nature*, an engraving showing the obverse and reverse sides of the medal.

MEDAL PRESENTED TO M. PASTEUR BY HIS ADMIRERS.

SIR ERASMUS WILSON'S MUNIFICENT GIFT TO MARGATE.

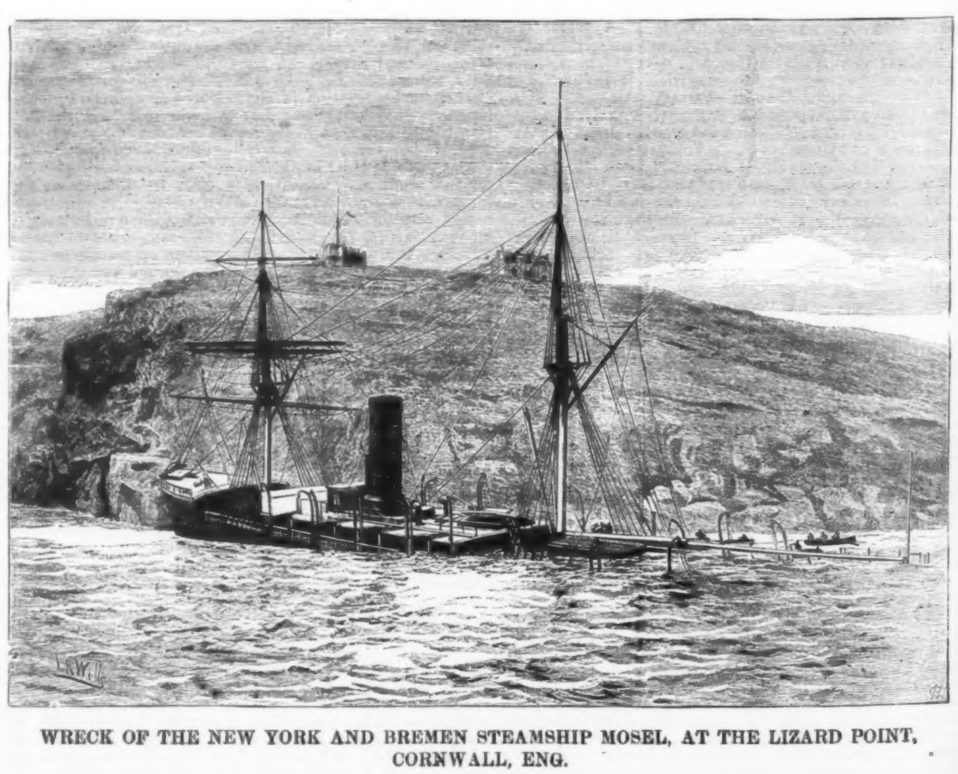
AT a recent meeting of the Governors of the Margate Royal Sea Bathing Infirmary, Sir Erasmus Wilson, F.R.S., handed over the key of the magnificent new wing of the Infirmary, to be named the Erasmus Wilson wing, which he has built at an estimated cost of over £150,000. The wing includes two large day-rooms and four dormitories, each to contain sixteen beds, with a swimming bath capable of containing 15,000 gallons of sea water.

WRECK OF THE MOSEL.

THE steamship Mosel, belonging to the North German Lloyd's Company, a large and splendid vessel, which left Southampton for New York on the 8th of August, was involved in a thick fog at the mouth of the Channel; and at half past eight next morning ran upon the rocks at Church Cove, one mile east of the Lizard Point of Cornwall, England. She had come from Bremen with 650 German emigrants, and with a general cargo for the United States, and had taken on board mails and specie at Southampton. The ship was going thirteen knots an hour when she struck stem first, and her bow was lifted so that she instantly forged ahead, with large rocks under her entire length. There was no alarm on board, as the ship maintained an upright position, and the captain assured the passengers that they would all be landed safely. The National Life Boat Institution's life-boat Anna Maria, under the direction of the Rev. P. Vyvyan Robinson, was soon alongside, and prompt measures were taken by means of both ship and shore boats for landing the passengers. It was nearly low tide, and cables were speedily got out and made fast on shore. As the tide rose, some of the ship's compartments began to admit the water. It became necessary to quit the ship, which may yet be saved, with the cargo, but happily there was no loss of life. The steamer Rosetta, of Falmouth, which was cruising in the neighborhood, took the mails and specie to Falmouth, whither the passengers were also conveyed. The greater part of the cargo was got out of the ship, soon after which she became a total wreck. Our engraving is from the *Illustrated London News*.

BULLIVANT'S SEA ANCHOR.

ONE of the attractions at the Exhibition of Life Saving Appliances at the Alexandra Palace was the sea anchor of Messrs. Bullivant & Co., of 72 Mark Lane, London. This anchor has been invented for the purpose of enabling disabled vessels to ride out heavy gales and storms, and for other similar purposes. The application of the anchor is seen in Fig. 1 of the engravings on p. 139, while Fig. 2 shows it in detail. It will be seen to consist of an oblong raft, to which is attached canvas bags or drogues, the same length and breadth as the raft. The dimensions of the raft and drogues may be regulated to offer varied resistances adaptable to small or large vessels. The raft or float may be made either of well-seasoned wood, well calked, or of iron or steel. It is constructed with floating power sufficient to support the bags with their expanding bars, and steel wire rope pendants, and the weight of steel wire towing hawser, which would be brought upon it. At the front of the raft eye-bolts are placed to receive the steel wire towing span, and a strongly hinged flap one foot in depth is also dropped in a vertical direction in front of the raft to give additional resisting force in dragging. The bags are attached by means of shackles and steel wire pendants to eye-bolts at the back of the raft and connected to each other by short steel wire pendants and shackles. These bags are extended by means of a bar-iron rim at the mouth of each bag, stiffened with a cross bar of iron at the center of each. The sea anchor when stowed away occupies a very limited space. The bags lash close to the raft, and the whole may be secured to the bulwarks on the outside of the bow of a vessel. In this position the anchor is always ready for immediate use. It can be supplied with varied resisting areas, to meet the requirements of any class of vessel. The re-



WRECK OF THE NEW YORK AND BREMEN STEAMSHIP MOSEL, AT THE LIZARD POINT, CORNWALL, ENG.

sistance offered by the raft and bags, or drogues, is, as a rule, kept as nearly as possible in equal ratio to the resistance offered by the vessel to which it is supplied in being towed at varying speeds. By this means a disabled vessel in a heavy gale is enabled to lay out ahead a sea anchor, which exercises the same power in holding her head to sea as a powerful tug would do.

There are a variety of purposes for which it may be used on board vessels to advantage; such, for instance, as a break-down of the engines or rudder, or in the case of a heavy-laden cargo steamer of low power and speed finding it dangerous to continue her course in heavy weather with flowing seas, she may ride to such an anchor in safety. In case of a vessel foundering, a life raft capable of carrying from 15 to 20 persons may be quickly constructed by dis-

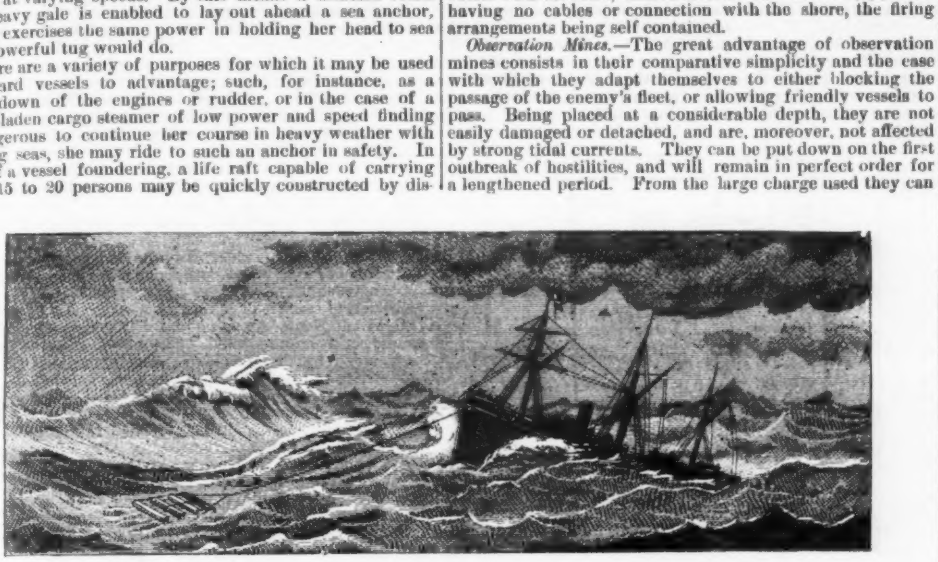


Fig. 1.

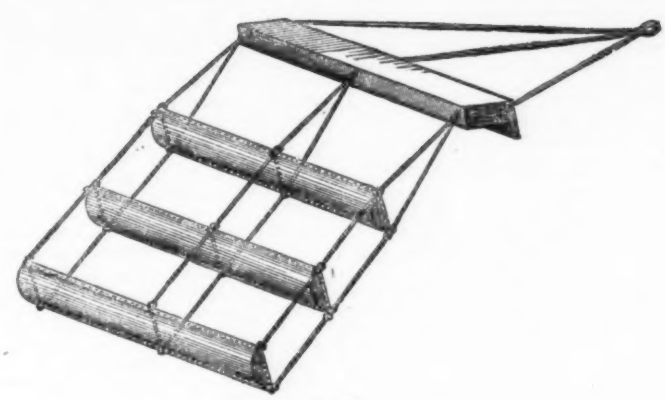


Fig. 2.

connecting the bags or drogues, and connecting two rafts or floats by means of spars across each end, secured to the eye-bolts used for the towing span and drogues. In cases where only one sea anchor raft is carried, the single raft would be sufficient to save several lives. A sea anchor thrown out ahead of any disabled vessel in danger of being driven on a lee shore would check the disaster for a much longer period, if not prevent it entirely. Should a vessel get on a lee shore, the raft without the bags or drogues, with a steel wire hawser attached to it, would form immediately a safe communication between the vessel and the shore. It will thus be seen that the sea anchor forms an important means of saving life at sea, and, as such, merits attention.—*Iron.*

TORPEDO WARFARE.

The public have lately learnt by perusal of the daily papers, many cogent arguments for and against the much talked of Channel Tunnel, and thus have been made fully cognizant of the advantages incident to our insular position. But few, perhaps, are aware that these natural advantages have, by the aid of science, been greatly enhanced during the past few years. A visit to the interesting exhibits of the War Department at the recent Electrical Exhibition at the Crystal Palace gave one an idea of the important part played in modern times by torpedoes in the defense of our naval and mercantile harbors. Fortunately for visitors, the authorities, taking a hint from the exhibition at Paris, placed their exhibits under the charge of a most obliging and intelligent sapper, whose chief duty lay in answering the questions of curious visitors.

The whole of the important duties connected with the defense of our harbors, with the exception, of course, of the forts and guns, have been entirely entrusted to the Royal Engineers, and several companies have been detached for this service. These men, during the summer months, are thoroughly trained in their duties, and put through a practical course of laying cables and testing mines, and also the manipulation of the various electrical instruments comprised in the equipment.

A harbor to be thoroughly protected requires not only to be defended by obstructions and mines, but these latter must also be protected by artillery fire. Mines alone can be more or less easily destroyed or picked up, unless the enemy in so doing are hampered by an effective fire from permanent coast defenses. On the other hand, forts alone will not prevent a vigorous commander from forcing a passage, the channel of which has not been obstructed by submarine mines. In proof of this, we may mention Admiral Farragut's passage of Fort Jackson on the Mississippi into the batteries of Vicksburg. Thus, although submarine mines can never take the place of artillery, their use in connection with it very greatly increases the value of the defenses.

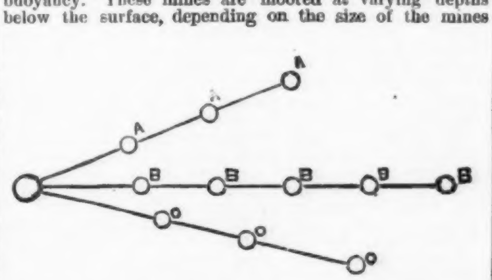
Torpedoes, like all other offshoots of that mighty agent, electricity, have of late developed very rapidly. It is only within the last few years that they have become a distinct feature of warfare. As long ago, however, as the Crimean War, chemical torpedoes were employed by the Russians to guard their harbors; but the American War of Independence greatly developed the science—an interesting and instructive account of which is given by Von Schiella in his treatise on "Coast Defenses."

Torpedoes may be classed under the following heads: (1) Those fired at will from the shore when a vessel is seen to be in their vicinity, generally known as observation mines; (2) those fired from the shore on the contact of the vessel with the mine, termed electro-contact mines; (3) those having no cables or connection with the shore, the firing arrangements being self contained.

Observation Mines.—The great advantage of observation mines consists in their comparative simplicity and the ease with which they adapt themselves to either blocking the passage of the enemy's fleet, or allowing friendly vessels to pass. Being placed at a considerable depth, they are not easily damaged or detached, and are, moreover, not affected by strong tidal currents. They can be put down on the first outbreak of hostilities, and will remain in perfect order for a lengthened period. From the large charge used they can be placed at comparatively great intervals, and by the aid of a recently invented apparatus can be fired with such accuracy as to explode within a few feet of a vessel going at full speed. The largest mine exhibited is one that holds 500 lb. of gun-cotton, the explosion of which would cause serious damage to any vessel within a radius of 50 ft. The general design will be seen by the following sketch, Fig. 1.

FIG. I

The case is made of thick boiler plates riveted at the joints, and fitted with rings for attaching the chains. Also an opening with water-tight joints serves the double purpose of loading the mines and fixing the firing apparatus, to be hereafter described. Buoyant mines, made to hold the same quantity of gun-cotton, though somewhat similarly constructed, are larger in dimensions, in order that they may have sufficient displacement to give a considerable buoyancy. These mines are moored at varying depths below the surface, depending on the size of the mines



employed and the nature of the channel to be defended. The mines being filled with wet gun-cotton, it is necessary to have a certain quantity of dry gun-cotton—generally termed primers—to set up the full force of detonation. The firing is effected by electric detonators, which are exploded by a voltaic battery from the shore. The primers and detonators are inclosed in an iron cylinder which fills the opening of the mine, and is secured by a water-tight joint. A polarized relay is also inclosed in the same cylinder to be used for testing the mines, to ascertain that the circuits are in good condition without the risk of exploding them.

Means of Firing Observation Mines.—Observation mines can be fired—(*a*) by one observer; (*b*) by two observers. (*a*) When observation mines are fired by one observer they are laid in rows, each row consisting of any number of mines, according to the width of the channel to be defended. Thus, A A A, B B B, C C C, are lines of mines converging on the observing station at O. The whole of the mines in each row are connected with it, and would be exploded on the ship crossing the line of sight. (*b*) When mines are exploded by the joint efforts of two observers, they are also generally laid on a system, so that the line connecting them converges on to one of the observing stations. Thus, A A A, B B B, are mines in line with the observer, O; but in this

case he does not fire the mines himself, but signals to the observer at M when the ship is in line with any of the mines. M then presses the key in connection with the mines, and should the telescope on his firing arc indicate that the vessel is over one of them, contact with the firing battery is established and the mine exploded. Circuit closers are generally attached to each mine, so that they can be fired at night, and when smoke or fog render observation impossible. A system of firing mines by separate intersections can also be arranged, in which case a single mine takes the place of the converging row already described. The instruments employed for observation firing, termed "observing arcs," are of two kinds, though identical in general construction—the one for the outer observing station, and the other for the inner firing station—see Figs. 2 and 3. The arc consists of a light open triangular frame-

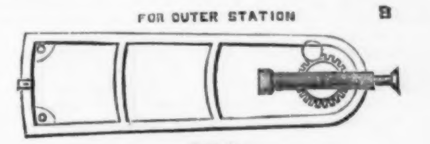
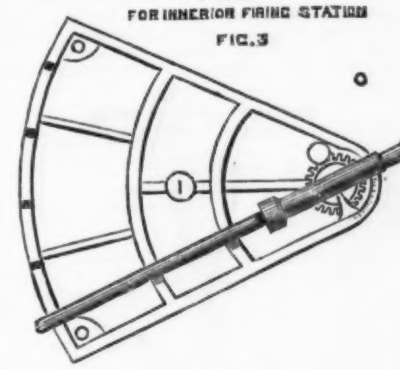


FIG 2

FOR INNERIOR FIRING STATION

FIG. 3



work, supported on three feet provided with leveling screws. At the apex is a vertical spindle capable of being raised or lowered, and traversed to the right or left by means of a rack and pinion. Attached to the spindle is an arm with vernier working over a graduated arc, and also a longer arm which sweeps over the outside arc. To the upper extremity of the spindle are fixed two Y's, in which rests a telescope. Sights having platinum contact pins are provided, which can be secured in the outer arc, so as to be in line with the mines, and which are also attached to the cable leading from the mines. A brass spring insulated from the long arm comes in contact with the sight when the telescope is directed at the mine, and on being connected with the firing battery explodes it.

Electro-contact Mines.—The great advantage of this kind of torpedo is that, being fired in actual, or at least very close contact with the vessel, a comparatively small charge of gun-cotton is sufficient to destroy or render her unfit for service. They also more effectually defend a channel at night or during a fog, when the observation mines above described would be quite useless. They have, however, certain disadvantages, such as being more exposed to injury by countermines, and are difficult to place out of sight in positions where there is a great rise and fall of tide. The mines exhibited, Fig. 4, hold about 100 lb. of gun-cotton,

100 LB. ELECTRO CONTACT MINE

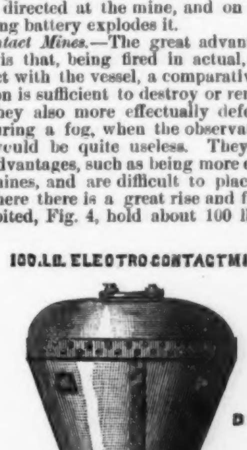


FIG 3

and should be placed at about 13 ft. under water, the exact depth, however, being dependent on the rise and fall of tide. The apparatus connected with submarine mines is

termed the circuit closer. This is either placed inside a wooden jacket and connected by cable with the larger descriptions of mines, or is fitted inside the 100 lb. electro-contact mine. The apparatus itself is in either case almost identical, and is protected by a gun-metal dome arranged with a washer for excluding the water. Three columns, A, Fig. 5, between which is placed a polarized relay, support

APPARATUS FOR CIRCUIT CLOSING

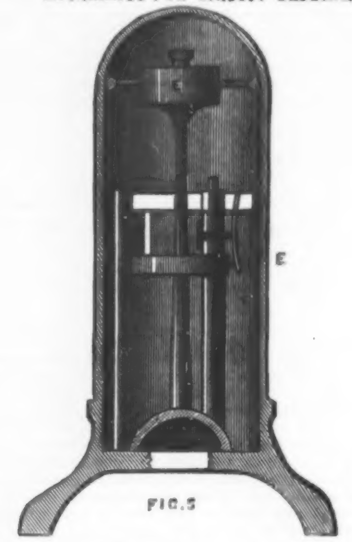


FIG. 5

an ebonite disk. Springing from the base is a steel pin, carrying at its top extremity an iron cylinder, E, surrounded with India-rubber. A ring attached to the dome limits the play of the cylinder, and prevents a permanent deflection of the spindle. Attached to the ebonite frame are three springs with platinum contact points, the sensitiveness of which can be regulated by screws. Half way up the spindle is fixed an insulated brass-plate having platinum points which come in contact with the platinum projections on the springs. In the later forms of the apparatus a helical spring takes the place of the vertical spindle. When the mine is struck the vertical spindle is thrown violently to one side, and one or other of the platinum points comes in contact with the springs and closes the circuit. A signal is then given in the test-room, when the operator can fire the mine, and by pressing down the firing key the action can be made automatic. Thus friendly vessels can be allowed at any time to pass, as their contact with the mines merely sends a signal to shore. The accompanying sketch, Fig. 6,

GROUND MINE WITH CIRCUIT CLOSER

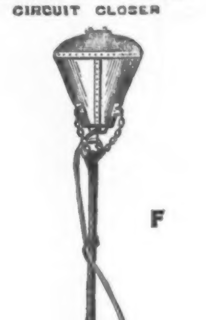


FIG. 6.

shows the method of fixing a circuit-closer to a ground mine.

Shutter Apparatus.—The instrument on which the signals from the circuit-closer or electro-contact mine is recorded is called the shutter apparatus. It consists of a mahogany box nearly 4 ft. long and 5 in. broad, in which are inclosed seven electro-magnets; a projecting base-board contains the connections for the firing plugs. To avoid the effects of concussion the box is supported on India-rubber feet. Each of the electro-magnets has adjustable pole pieces, A A, and vertical armatures, B, pivoting on their centers, and kept in a normal position by means of spiral springs, D, the strength of which is adjusted by mill-headed screws, E; the shutter arms pivoting at H, Fig 7, are held in position by platinum pins on the armature, so that when the arm is attracted by a current passing through the electro-magnet, the weight of the metal disk causes the arm to fall and strike a bell. Thus the operator's attention is attracted, and at the same time the arm, passing between contact springs, makes connection with the firing bar.

Detonators and Charges for Submarine Mines.—The only substance used for the charges of submarine mines in the English service is gun-cotton, the great advantage of which consists in its absolute safety when wet, and also in the fact that its full power in that state can be developed by the detonating of a comparatively small charge of dry gun-cotton. Mr. Abel, the chemist for the War Department, discovered that all explosive substances, even including gunpowder, were susceptible of more violent explosions through the agency of detonation. He also noticed that a very small quantity of the mercury and silver fulminates, compared with other explosives, produced the necessary detonation, by the suddenness of the blow incident on their ignition. For this reason all the service detonators are made with a small charge of fulminate of mercury inclosed in a metal tube, which is made to form part of an electric fuse, or may be attached to an ordinary Bickford fuse. Several kinds of detonators are used in the naval and military services, sections of which were exhibited by the War Department. The heads of these fuses are colored differently to indicate their nature—thus, black indicates that high tension electricity must be used to fire them; while for white heads, on the contrary, low tension is required. The

SHUTTER APPARATUS

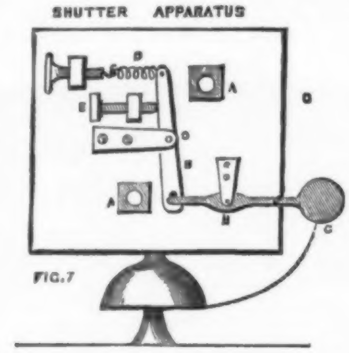


FIG. 7

tubes of all detonators containing fulminate are painted red. In the high tension fuses the current is carried from one wire to the other in the head of the detonator by a badly conducting substance composed of the subphosphides, and sulphides of copper and chlorate of potash. In the low tension fuses the ignition is caused by the heating of a thin iridio-platinum wire embedded in a mixture of gun-cotton and powder. Various forms of these detonators are made for different purposes, and distinguished from one another by numerals.—*The Engineer.*

[Continued from SUPPLEMENT No. 350, page 5581.]

THE PANAMA CANAL.

By MANUEL EISSLER, M.E., of San Francisco, Cal.

VII.

THE INFLUENCE THE OPENING OF THE PANAMA CANAL WILL EXERT ON THE WORLD'S COMMERCE.

ALL that is required to get a clear understanding on that subject is to look at the map of the world.

The American isthmus raises up like a rocky wall, which separates the two great oceans of the world: the Atlantic and the Pacific. The result is that to go, for instance, from Liverpool, from Havre, from New York, to San Francisco, in California, it is necessary to make the tour of the two Americas, sail a distance of 18,000 miles, to dare for 60° Southern latitudes, the storms and icebergs of Cape Horn, and, by sailing ships, to take the chances twice to meet in the vicinity of the line those disheartening calms which sometimes last for several weeks.

The ships which leave (having Europe as their destination) from ports in Ecuador, Peru, Bolivia, Chili, that is to say, from Guayaquil, Callao, Iquique, Cobija, or Valparaiso, are equally obliged to pass by the Cape Horn to reach their destination for the purpose of discharging in the European ports the guano, cacao, niter, copper, and wools. If we wish to go from Boston, or from New York to Hawaii, Japan, China, to Australia, we have again to make the tour around Cape Horn, unless it is preferred to go in some cases by way of the Suez Canal.

Is it necessary to multiply these examples?

They are well known. The wall at the Isthmus bars the route which is the shortest and safest. This barrier has to be torn down. The canal once opened, ships will be able to pass freely, and will be able to economize half or one-third of the distance which they would have had to travel by the old route.

Naturally this economy in time and distance will reduce itself in a great saving in dollars and cents, and great economies will be realized on the freight of transportation, insurance, and interest of the capital invested.

The influence which the canal will exert on the commerce and industry of each nation will be great. The opening of the American canal will complete what the Suez Canal has commenced. Once opened, the ships find a comparative calm highway, with short routes.

The international maritime commerce will meet with such facilities that it will develop into greater proportions. It will be the same with the industries of the different nations, as they will receive the raw materials in larger quantities and at lower rates, thereby stimulating many branches of manufacturing.

The construction of marine steam engines will also receive new improvements, as has taken place at the opening of the Suez Canal.

To the construction of steam power is connected the coal mining industry and metallurgy. If the first progresses the other will follow. The wind, nature's great motive power, costs nothing, but science has proved that steam applied to compound engines is still cheaper, as we have arrived to a degree of perfection where, with two pounds of coal per hour, we can keep up one horse power of steam, which has made steam cheaper than the sail, and has in that way established the future of the Suez Canal.

We have had there striking examples: freights from Marseilles, or Liverpool, for Bombay, Calcutta, or Shanghai, fell from twenty dollars to seven dollars, and steamers bring now economically to Europe not only spices, indigo, tea, silks, but also cotton, sugar, coffee, rice, hides, oil seeds, etc., in one word, all the merchandise of lesser value, which formerly had to be carried by sailing vessels.

From this will arise a great transformation in the merchant marine, which would be one of the economic phenomena of our age. Naturally such a phenomenon could not be brought about without some complaints, as each great step toward progress is generally fatal and productive of individual disasters, but the universality of human kind is benefited, and is the great aim of the canal.

There is no doubt that new outlets will be created; there will be an increase in the exchange of raw material against manufactured products. All of Central America is to-day deprived of a sure maritime communication on both oceans, and the whole of Central America, like Costa Rica, Nicaragua, Salvador, Honduras, Guatemala, will start with a new lease of life as soon as the canal is opened. These are choice countries for coffee, cacao, sugar, indigo, cochineal, cotton, and other textiles, rice, corn, balsam, caoutchouc, etc., etc., and many other vegetable products. Fine woods and dye woods are there in abundance. As to minerals, iron, copper, lead, gold, silver, precious stones, sulphur, and numerous others are found there and extracted to a small extent. This will be a complete transformation of these countries, which are only lacking now proper means of transportation, and they will very quickly become, like the United States, active exporters to Europe of raw materials. In return Europe would send them, in growing quantities, its manufactured articles.

Is it not possible that an increase in the exploitation of these natural riches will bring an increase in population and the colonization of these countries, which will give them more unity and that politic stability in which they are lacking to-day?

Is not American enterprise and the progress in railroad building bringing about some remarkable changes in Mexico?

Whatever the advantages may be which Spanish America will derive from the opening of the canal, it is the United States of North America who will derive the greatest advantages from the canal. The world at large is already astounded by the formidable development of their home industries and their exterior commerce; their astonishment will grow more once the canal is opened.

Like England at Suez, they will occupy in the statistics of the American canal the preponderating place for the number and tonnage of their ships. The other nations will be way behind in their proportionate figures.

With an increase of commerce the intercourse of nations becomes closer and aids in spreading the ideas of progress and general advancement; not alone aiding in the material welfare of mankind, but also in its intellectual aggrandizement.

It has been reserved for our age to crown the lower motives in these enterprises, often of mere gain and adventure, with those of extending over the East the highest type of civilization and Christian enlightenment, hopefully to be conferred upon it by every means tending toward the closer intercourse and fellowship of men.

To whom will the world have to thank for the accomplishment of this great work? It is to the immortal creator of the Suez Canal, who, by his indomitable energy and his great will, aided by a high intellect, has united the interests of great money powers in the execution of the interoceanic canal of the two worlds, and no doubt the nations at large will wish the uniting of the waters of the Atlantic and Pacific may be witnessed in person by Count Ferdinand de Lesseps.

I.—THE COMMERCE OF THE PACIFIC STATES WITH THE ATLANTIC STATES.

Mr. Lavasseur has prepared for the Congress in Paris a series of statistical tables in regard to the commerce of the different countries who will avail themselves of the canal, or are likely to do so, for their traffic. These statistical tables are very extensive and instructive, but they are too voluminous to be embodied in this work, and therefore I simply give the *résumé* and the deductions he has drawn from his calculations and estimates.

The states which are watered by the Pacific Ocean form two great groups. The western group, which comprises China, Japan, and the East Indies, and also the English colonies of Australia. The eastern group, composed of the South American States, Central American States, and the coast of the United States, and British Columbia; between these two groups are some islands distributed in the Pacific Ocean, like the Archipelago, of Tahiti, and the Sandwich Islands.*

The European commerce remained for a long time in China and Japan in a precarious situation, which prevented its development. Nevertheless the importance of the eastern market, with its 400,000,000 inhabitants, and the demand which the West had for certain products of China, maintained the relations, in spite of the hard conditions which were made to Holland at the island of Decima, and to the English and French merchants at Canton.

The business which Europe and America made with China at the commencement of the nineteenth century was estimated at over 200,000,000 francs. (Importation, 104,000,000 francs, exportation, 122,000,000 francs.)

The treaty of Nankin, 1842, in modifying these conditions and in opening five ports to foreign nations, inaugurated a new era; the treaties of Tien-tsin (1858) and of Peking (1866) still more multiplied the points of commercial intercourse and contributed to the progress. The development has not been as rapid and regular as has been anticipated. The estimate of the Chinese custom houses in the open ports show a commerce of a 1,000,000,000 francs in 1860, and 1,121,000,000 in 1877.

The states of Asia, the English colonies of Asia and Australia, will continue to direct their vessels by the old routes. The states of Europe, whose importation and exportation represent more than 550,000,000 francs in 1876, may continue to send their ships by Suez, or take advantage of the new route.

As to the United States of America, they will take immediate advantage of the new route, and in 1860 their traffic there amounted to 110,000,000 francs ($22,000,000), and in 1876 to $25,000,000. But these figures do not give an exact idea of the progress of their relations with the Orient. The year 1860 was followed by five years of languor on account of the war of secession, and during that period their commerce with China had fallen to $12,000,000. But in 1873 we see that figure creep up to $37,000,000. A commercial crisis set in at that time. Under its influence commerce suffered again. The two principal articles of importation fell, namely, silk, from $6,500,000 in 1873, to $4,000,000 in 1874; and tea, in spite of the abolition of duty on it, from $20,000,000 in 1873, to $17,000,000 in 1874, and $10,000,000 in 1878. In 1879, when this cloud which hung over our commerce commenced to disperse, this commerce raised again to upward of $40,000,000.

In round figures it can be said that our commerce has raised with those countries in the last eighteen years up to 1879 to over 40 per cent.

Japan stands in the same position as China. The Americans were the first to break, in 1854, the isolation in which this country kept itself, and since the treaties of 1858 and the opening of some of its harbors, that country has maintained relations with England, the United States, France, and other countries of the world. The reforms which the Japanese have introduced so energetically in the last few

* This geographical distinction is made from an American standpoint, and have to be reversed when their relation with Europe is considered. China and Japan being the Orient, or East.

years insure their permanency, and Japan has thereby given an example of social transformation which is unique in its kind in the history of the human family. But, in spite of the activity of the population and the richness of some of its soil it is far from offering to commerce, by its population and agriculture, a future equal to China. The commerce in the parts which are open to strangers is between 250,000,000 to 260,000,000 francs, about one-fourth of the China trade.

Here again the United States are more directly interested in the opening of the canal, as this will be the route American sailors will take. Our Custom House statistics show that in 1876 our commerce with Japan amounted to $16,000,000, and consequently the United States hold the second rank as to commercial relations with Japan, France first, and England third.

The Dutch Indies and the Philippine Islands are important countries in the Orient. The Dutch Indies had a commerce of 456,000,000 francs, and the Philippines of 179,000,000 francs in 1877, but the largest portion of this trade is only with Europe, consequently America's interest in an interoceanic navigation will be only a limited one there. Nevertheless the United States had with that region a commerce which in 1877–78 run up to $4,500,000 with Dutch India, and $8,000,000 with the Philippine Islands. The Isthmus route opened, about 62,000,000 francs will fall to the United States, and 500,000,000 francs to European parts.

In the Australian Colonies England governs everything at present, but as it is a growing country, with a brilliant future, there is no telling what influence the canal may exert on Australia. It is toward England that its whole commercial current directs itself, and the seven colonies which Australia is composed of interchange among themselves their different products. The United States of America, in their statistics estimate at $7,000,000 the portion of their commerce in Australia for the last six years, on a traffic which amounts to 2,000,000,000 francs yearly, of which half belongs to the oceanic world and the other half to European nations.

We will cite here New Caledonia and Tahiti, whose commerce figures up from 7,000,000 to 13,000,000 francs. We renounce entirely the commerce of the islands of Polynesia, although the same will amount to considerable after the opening of the canal, especially in the exportation of mother of pearl, cocoanuts, and certain woods.

More important is Hawaii or the Sandwich Islands. Its commerce, which also had its crisis, was over 20,000,000 francs in 1876, and over 10,000,000 francs belong to the United States. The commerce of these islands will go nearly all by the American Isthmus Canal. (In late years this commerce has grown to large proportions on account of the Reciprocity Treaty, outside of its direct relations with San Francisco, where it has its great depot for its sugar.) It is safe to estimate at the present time that 417,000,000 francs represent the portion which the United States have in the commerce of those parts of Asia and Australia watered by the Pacific ocean and from the islands situated in that ocean.

	Francs.
China	200,000,000
Japan	80,000,000
Malaisia (India)	62,000,000
Australia	35,000,000
New Caledonia, Tahiti, Sandwich Islands	40,000,000
Total	417,000,000

These 417,000,000 represent the double current of importation and exportation, which has a tendency to pass by the American coast of the Pacific or by Cape Horn.

The question is: will the interoceanic canal have the power to reverse the other current which from the Asiatic coast and from Australia directs itself by Suez?

In other words, shall we take in consideration the total commerce of these countries, or shall we count only on that portion belonging to the United States?

Two opinions exist on that subject:

The first is, that the Suez route is not only the shortest between Europe and Asia, but also the most convenient for steamships, which find at short distances harbors and depots, like Aden, Point de Galle, Singapore, and consequently they can reduce their cargo of coal, and in that way have more room for merchandise. And it is true that, between Japan on the interoceanic route and the American coast we find only Hawaii and some rocks. Australia is more favored in that respect, as they could utilize the islands to be met with on that course, from Fiji to Galapagos.

The other opinion is, that the facilities and the economy of navigation in the regions of the trade winds would modify the form of the merchant marine, as has been already done by the opening of the Suez route, and that the vessels in future would carry more sail and also a steam engine which would occupy a small space and use little coal, and who would go from Europe to Asia or Australia by the American Isthmus, and from there to Europe by Suez, making in that way the tour around the world, having the wind from behind, when the monsoons or trade winds are favorable. This opinion is mostly indorsed by ship captains and navigators.

It is, therefore, proper to bring into account a part of those two milliards of commerce of this portion of the Pacific with Europe (China 550,000,000, Japan 30,000,000, Philippines and Dutch Indies more than 400,000,000, English colonies 1,000,000,000). It is estimated that 500,000,000 francs can be taken, or one-quarter, which will eventually pass by the interoceanic route. What is certain, that the exportation to the European countries, which is much larger, especially in weight, than the importation, will follow the western route. The European importation in these regions will probably in course of time follow the new route.

The Indian Ocean forms the third commercial category. Here it is not necessary to occupy ourselves with Europe; but we can apply for the United States a rule of evaluation analogous to the one which we come to take for the commerce of the European States of the western coast of the Pacific. Mr. Kelly and Admiral Davis, in 1857 and 1866, counted the whole traffic of the United States and India to the account of the interoceanic canal, and this can be done now, as the United States cannot use the Suez Canal to go to India or to come back from there. But it will be safer to take only half of that traffic. This traffic amounted to 110,000,000 francs in 1860, and after diminishing to one-half during the war of secession, the same increased to 170,000,000 francs in 1876. Consequently the India business can be valued at 60,000,000 francs.

The question is in some respects simpler for the American coast of the Pacific. As the principal part of the most southern State is Valparaiso, situated at not less than 20° north of the Straits of Magellan, and as the canal will shorten the road about 4,000 kilometers, there is no doubt that the traffic of that part of the Pacific with the north of the Atlantic can be counted on as a future customer of the canal. Chili, the most southern of the Republics, has also the greatest extent of coast and the biggest portion of commerce. Its copper ores, grain, hides, nitrate of soda, which it exports, are merchandises the demand for which will increase in Europe, and which employ, on account of their value, a great many vessels. The commerce of Chili was 250,000,000 francs in 1860, 365,000,000 francs in 1876, 300,000,000 francs in 1877. The difference between 250,000,000 and 300,000,000 does not indicate the true progress. Chili has grown rapidly; in forty years its exterior commerce has quadrupled, as in 1844 its commerce amounted to 75,000,000 francs. But like most countries, it suffered from the crisis which existed in America, Europe, and Asia; and that is why the importation and exportation which had reached 383,000,000 francs in 1873 was only 300,000,000 in 1877.

These 300,000,000, or, more exactly, the 365,000,000 of 1876, do not belong entirely to the transit of the isthmus. We must deduct the portion of the Argentine Republic and Uruguay (21,000,000 francs); those of the Republics of the Pacific coast (46,000,000 francs), probably also the part of Brazil and that which San Francisco will retain in the exchanges with the United States. The 365,000,000 find themselves reduced, even after the elimination of the influence of the crisis, to about 300,000,000 francs.

Bolivia has on the ocean a very narrow outlet and of which she is not entirely mistress, so that it could not utilize all the resources with which this country is endowed. Its commerce does not surpass 50,000,000 francs, and the war which the exploitation of the guano and nitrate of Mejillones has brought about between Chili and Bolivia, sustained by Peru, has no doubt diminished this estimate.

Peru on these shores is the rival of Chili, but placed under different climatic conditions. The coast region is partly a desert, as there is no rainfall there, and cotton and sugar grow only in the neighborhood of the torrents descending from the Cordillera. But the Cordillera has cultivated camps, the Puna has fresh pastures and cattle, the eastern slope of the plateau has forests which furnish or could furnish numerous articles of exportation; the mines, guano, nitrate of soda, form other sources of commerce; and although exact figures cannot be obtained, there is a progress there. The custom-house receipts, which were 17,000,000 francs in 1869, reached 42,000,000 francs in 1873, and fell to 35,000,000 in 1875. Guano represents on an average since ten years about 400,000 tons. Nitrate of soda, whose exportation amounted to 300,000 tons before the breaking out of the war with Chili. Sugar, which in most plantations along the coast has been substituted to cotton since the ending of the American war of secession, has given satisfactory results, 16,000 tons exports in 1873, 90,000 tons in 1878. Statistics estimate that the total commerce of Peru reaches and even surpasses 300,000 francs, and that half of that commerce is done in Callao.

The same can be said of Ecuador. It is at Guayaquil that is concentrated the commercial activity, and we can judge of the general progress of the Republic by what has been accomplished in thirty years at that port: 13,000,000 francs in 1847, 44,000,000 francs in 1858, 55,000,000 francs in 1873, 48,000,000 francs in 1878.

We observe everywhere the same phenomenon of growth in consequence of the progress in navigation, and by the subsidence of the effects of the commercial crisis. The total of the commerce of the Ecuador, which consists mainly in the import of cotton goods and exports of cacao, is valued at 60,000,000 francs for 1874.

The commerce of Colombia, which is valued at 115,000,000 francs in 1873, is divided between the two oceans. The greatest portion follows the valleys of Cauca and Magdalena, and finds an outlet on the Atlantic, at Sabanilla and Carthagena. This is not because the roads there are in a good condition; the French consul reports that a printing press has cost $1,000 freight to Bogota. But the high chain of the Cordilleras have rendered to this date the access to the Pacific difficult; and therefore the tonnage of the navigation in the ports of the Pacific is only one-tenth of the total tonnage; which reduces to about 11,000,000 francs the portion which can to-day be brought to account of the canal.

Panama owes entirely its importance to the transit.

Of the five Central American republics, four have access to both oceans; but, contrary to Colombia, they have their principal ports on the Pacific. Competent authorities think that the commerce has doubled in fifteen years. In 1876, the same amounted to 127,000,000 francs, of which 100,000,000 belong to the interoceanic commerce.

Mexico has few ports on the Pacific: San Blas, Manzanilla, Acapulco, Mazatlan, Guaymas; its commerce by that ocean has not been over 75,000,000 francs in 1873, on a total of 300,000,000 francs. This commerce has also made considerable progress, if we take a longer period in consideration. But the same has also been subject in the last decade to the influence of a political and commercial crisis.

The States and Territories of the United States on the Pacific, California, Oregon, Washington Territory, whose maritime commerce is done entirely through the ports of Los Angeles, San Diego, Monterey, San Francisco, Astoria (indirectly Portland), Puget Sound.

San Francisco dominates on that whole coast and attracts almost the whole commerce; the other ports are merely, up to the present time, its satellites.

The port of San Francisco had a commerce of 1,124,000,000 francs in 1875, of 1,290,000,000 in 1876, and 1,253,000,000 in 1877. Before 1848 this commerce amounted to very little. No port, not alone on the Pacific Ocean, but in the whole world, can boast in a quarter of a century of such a degree of prosperity, in passing from nothing to a commerce of over a thousand million of francs.

But some deductions have to be made. In the first place, 666,000,000 francs for the precious metals (378,000,000 for importation, and 288,000,000 for export in 1876) which will not take the route of the canal, and will not count in respect to tonnage; in the second place, the commerce with the Pacific States, which has been enumerated once as amounting to 417,000,000 francs; in the third place, a portion of the California products, which the railroads will take away from the canal.

But still a large sum remains. As to export, the cereals, flour, amounting to 100,000,000 francs in 1876; wool, 39,000,000 francs; quicksilver, 10,000,000 francs; salmon and other fish, 10,000,000 francs; furs, pelts, and hides, 10,000,000 francs; wines, 4,000,000 francs; preserved fruits, 3,000,000 francs; in all, over 200,000,000 francs for export, and 50,000,000 francs for import. We can add another 50,000,000 francs as the sum representing the transit between the two coasts of the United States, and we arrive to a grand total of 300,000,000 francs, which represents, not a certain estimate, but a simple estimation.

British Columbia is one of the clients of San Francisco; she has sent to the United States 10,000,000 francs of products in 1878, and has drawn 1,000,000.

The minor importance of the other markets, such as Alaska, which gravitate around San Francisco, allows us to neglect them in our calculations.

We have also to note the whalers of Maine and Massachusetts, who go to fish on the Alaska coast and Behring Straits, and whose number amounted to 17 (4,300 tons) in the 1877–78 campaign.

If we make a total of the traffic of the American coast of the Pacific, we find the same amounts to 1,206,000,000 francs, namely:

	Francs.
Chili	300,000,000
Bolivia	50,000,000
Peru	300,000,000
Ecuador	60,000,000
Colombia	11,000,000
Central America	100,000,000
Mexico	75,000,000
United States	300,000,000
British Columbia	10,000,000
	1,206,000,000

To this sum has to be added:

1. The 417,000,000 francs of the commerce of the United States with the west coast of the Pacific and Polynesia islands.....417,000,000
2. The commerce of the United States with the Indian ocean..... 60,000,000

And we have a total of.....1,683,000,000

It is well in making these calculations, instead of taking average figures to take the minimum of the average. The basis of these calculations will be more reliable by taking lower figures.

Consequently we will assume only 1,300,000,000 francs, the value of merchandise which could pass or may pass in 1876 from one ocean to the other.

On the other hand we have to add 500,000,000 francs, which we suppose ought to be the portion of commerce between Europe and the Orient which will take advantage of the new canal route.

In uniting these two figures we have:

	Francs.
	1,300,000,000
	500,000,000
Total of	1,800,000,000

II.—TONNAGE OF THE COMMERCE BETWEEN THE ATLANTIC AND PACIFIC.

In considering the question of tonnage, it is the volume and not the value of the merchandise we have to consider—as the toll will be collected on the tonnage.

The question before us now is to convert the 1,800,000,000 francs into tons; and as different articles of commerce have different prices, we have to adopt different standards of values, and it will be necessary to adopt for certain bulky goods of a known tonnage an average valuation. For instance:

360,000 tons of wheat and flour for California.
400,000 tons of guano.
300,000 tons of nitrates.

A total of 1,060,000 tons, which are worth 200 francs per ton, representing a value of over 200,000,000 francs, which have to be deducted first from the traffic of 1,300,000,000 francs.

The next question is, how to transform into tons the remaining 1,100,000,000 francs? Some articles have quite a high valuation—like coffee, 2,020 francs per ton; cocoa, 1,780 francs; indigo, 17,500 francs; wool, 2,250 francs; hides, 1,750 francs; quinquina, 7,000 francs; copper ores, 1,200 francs; tallow, 1,200 francs. Again, there are other articles of minor value, like vegetable ivory and dye woods, which are worth only 100 francs per ton. English statisticians have adopted 375 francs per ton as an average number for similar calculations, and we will also adopt 375 francs as the value per ton, to divide into the 1,100,000,000 francs and 500,000,000 francs, and we will get the following results:

1. 1,000,000 tons resulting from the direct estimation of the tonnage of certain merchandises.
2. 2,935,000 tons resulting from the division of 1,100,000,000 francs by 375 francs per ton.
3. 1,333,000 tons resulting from the division of 500,000,000 francs by 375 francs per ton.

5,268,000, or 5,250,000 tons in round numbers.

Now the question arises, can these figures be verified?

Admiral Ammen states in a statistical communication for 1877–78, that there was a movement of 757 ships having a tonnage of 971,455 tons in the commercial intercourse of the United States, on the two oceans, and the movement between the Atlantic ports of the United States and the foreign ports with the United States. But this enumeration does not seem complete, and the sums which we set off in the statistics of 1877–78 differ from these figures, and here is the abstract:

	Tons.
1. Tonnage of American ships, with cargo or ballast, coming in or clearing out of ports of the United States, from or for ports of the Pacific (the coast of the United States on the Pacific not included)	841,000
2. Tonnage of American ships, with cargo or under ballast, at the entrance or clearance from ports of the United States, from or for ports of the Pacific, situated outside of the American continent	455,000
3. Tonnage of foreign vessels, with cargo or ballast, at the entrance or clearance from ports of the United States, from or for ports of the American coast of the Pacific (the coast of the United States not included)	237,000
4. Tonnage of foreign vessels, with cargo or ballast, at the entrance or clearance from ports of the United States, from or for ports of the Pacific, situated outside of America	348,000
5. Tonnage of the coasting trade of San Francisco (entrance and clearance together)	587,000
6. Tonnage of the coasting trade of other ports of the United States on the Pacific coast (entrance and clearance)	975,000
Total	3,443,000

It is true that a considerable portion, about 1,000,000 tons, comes back to San Francisco, whose total tonnage was 1,229,000 tons for the exterior commerce of 1877–78, and 587,000 tons for the coasting trade, and that San Francisco will retain a large portion, and if it is only the 488,000 of British Columbia trade which is counted in among the foreign traffic, and is principally represented by the business which the weekly steamer line is doing with that section of country; and by leaving out the whole coasting trade of the other ports of the Pacific, as the same may have its center in San Francisco, there always will remain 2,000,000 tons for the United States.

This number, although differing from Admiral Ammen's estimates, agrees with the number (1,875,060), which Admiral Davis, in 1866, adopted as relating to the commerce of 1857.

The commercial tables of France give for the regions which we have considered as being in the circle of attraction of the future canal, 356,000 tons as entrance and clearance, including vessels under ballast.

The statistics of the English navigation give for the same regions, and including the ships under ballast, 1,050,000 tons as an average for 1870–76, and 1,200,000 tons for 1876. We can, in basing ourselves on the proportional commercial importance of other European nations in these countries, establish a hypothesis as to Germany and other countries at total equal to France's. And we obtain in that manner:

	Tons.
For the United States	2,000,000
" England	1,050,000
" France	356,000
" other countries	356,000
Total	3,762,000

This result is inferior to 3,935,000 tons (1,000,000 and 2,935,000), obtained by the other proceeding, and seems to indicate that it would have been better if we had applied without distinction the divisor 375 to the whole 1,300,000,000 francs; the quotient would have been 3,733,000 tons, very nearly equal to the above result.

As we are reduced to a hypothesis, let us reduce the above number and call it in round figures 3,500,000 tons, and add to it 1,333,000 tons, resulting from the division of 500,000,000 francs by 375 francs, and forming the profitable portion of the commerce between Europe and the Orient.

The grand total in tons will be

3,500,000
1,333,000

4,833,000, or in round numbers, 4,830,000.

If it is considered that the regions of the United States on the Pacific export 1,000,000 tons by Cape Horn (1878), and that the Central Pacific Railroad has a movement of over 1,000,000 tons, going and coming, it is safe to take the above figures as correct.

III.—The Commerce of the Atlantic and Pacific in Ten Years.

We have found 1,623,000,000 francs for the commerce of the year 1876 (1,300,000,000 francs after reduction). Estimates of the same kind, made with the same reserve and with more uncertainty for some countries, give us for the commerce of 1860 the sum of about 800,000,000 francs. The increase in business for fifteen years was therefore somewhere about 100 per cent., and the annual progression a little below 6 per cent.

	Portion of the Commerce which interests the Canal.		The total Commerce of these Countries in 1876.	
	1860	1876	Neuman and Spallard's Estimates.	Lavasseur's Estimates.
China	110	150	1,132	1,121
Japan	1	80	287	260
East India	35?	62	1,522*	635
Australia	20	35	2,287	2,200
Tahiti, Hawaii	15	40	20	20
Chili	200	300	384	365
Bolivia	25?	50	54	50
Peru	200	300	321	300
Ecuador	45	60	25?	60
Colombia	5	11	89	115
Central America	50	100	114	127
Mexico	50	75	317	300
United States	40	300	5,446	5,355
British Columbia and Alaska	5?	10	?	15?
Total million francs.	801	1,513	10,628	10,923

We can say with a certain amount of probability, that about ten years will pass from 1878 till the canal will be opened to traffic; that during these ten years, in spite of any crisis which may take place, the same will increase 60 per cent. But to follow our principle we will say that this increase will be about 5 per cent., so we will have for the year 1889:

1. 2,080,000,000 francs, or 5,250,000 tons.
2. 800,000,000 " " 1,999,000 "

7,249,000 "

According to our calculations these numbers represent at that epoch:

In the first place, the total of the commerce of the United States with the east of Asia and Australia.

In the second place, one-half of the commerce of the United States with the Indian Ocean.

In the third place, the commerce of the islands of the Pacific and the United States coast of the Pacific, with the States watered by the northern portion of the Atlantic.

In the fourth place, the coasting trade of the United States from one ocean to the other.

In the fifth place, one-half of the traffic of Europe with east Asia and Australia.

It will constitute, if not necessarily the total clientele of the canal from the beginning, at least the sources from whence its future business will be derived.

* M. Neuman and Spallard give only the commerce of Sumatra and Dutch Indies. This progress is below what the Panama Railroad has done, which transported 126,014 tons in 1875, and 152,477 in 1878.

We claim that we give in this *exposé* a very moderate estimate for this future commerce, as we have purposely adopted, everywhere, reduced figures; for instance, 1,300,000,000 for the commerce, when the addition gave over 1,630,000,000 francs; also one-quarter of the commerce of Europe with the Orient, and one-half of the commerce of the Indian Ocean and the United States, whereas other statisticians have invariably taken a larger part, and even the totality. Then we took 3,500,000 tons, whereas the calculations gave 3,935,000, and the other 3,762,000, and 50 per cent. as the increase of trade instead of 60 per cent. We have taken no account of the passenger movement across Panama, which is a considerable item and will be subject to taxation.

The writer wishes to draw attention to the fact that De Lesseps based his calculations on 6,000,000 tons commercial movement, and above figures will demonstrate if his estimate is correct or not.

IV.—Inferences to be drawn from the Traffic of the Suez Canal.

As soon as the canal will be opened, the conditions of the commerce between the two oceans will be profoundly modified, and the past will cease to be a criterion of the future. We have not the pretensions to express the hopes of the future by a numeric formula, and our object here is simply to give, by the assistance of an example, some ideas of what the great future may bring forth. The history of the Panama Railroad is not a sufficient illustration, as the necessity of a twofold reloading puts this highway in an unfavorable condition.

We address ourselves to the Suez Canal, and Mr. Fontane, the secretary of the Suez Canal Company, has furnished a special report on that question. Mr. Fontane has established that the tonnage of England with those countries of which the Suez Canal is the route was 2,292,000 tons in 1860, and that this tonnage augmented to 4,641,000 tons in 1877; that of France from 270,000 to 398,000 tons, and that of Netherlands from 316,000 to 414,000. Commercial crises hang over this traffic like over other countries. Nevertheless the progress has been 90 per cent., and more than 100 per cent. for England alone. The canal has incontestably contributed to this result, which is superior to the progress of other great commercial regions in the world, and would have been still more brilliant without the crisis and the vicissitudes of the cotton market.

The canal has greatly profited by this movement: it gave passage to 1,142,000 tons in 1871, and to 3,428,000 tons in 1877. The progress in that short period was 300 per cent.

Will the interoceanic canal have the same good fortune and make equally rapid strides?

V.—Routes which may make opposition to the Canal.

The Suez Canal unites Europe with Southern and Eastern Asia and Australia, uniting 330,000,000 people on one side to more than 700,000,000 on the other.

It has, so to say, no rival.

The travelers who take the railroad from Alexandria to Suez do not take away anything from the tonnage of the ships which pass through and which they find at the outlet of the canal. The caravans of Syria are entirely powerless to combat, and the railroad of the Euphrates, if some day constructed, would have no influence in that respect. The Asiatic Grand Central Railroad would have more, but in spite of the Russian activity we have not arrived as yet at the point where a train loaded at the Ganges can go and reach Moscow.

On the contrary, in proportion as ships are built adapted to modern navigation, the route of the Cape, which alone can make opposition, but requires a long circuit and only offers some advantages to sailing vessels, is less frequented. In that respect the Suez Canal can be entirely confident of its future.

The interoceanic canal has and will have opposition; but it will have such advantages that it will come out victorious. The two regions which the canal will draw nearer are the eastern and western coast of the United States; and that is one of the motives why the United States, of all the great nations of the world, are most interested in the cutting through of the isthmus. There are other motives: New Orleans, Baltimore, Boston, New York, are the great ports which the canal will bring nearer to all the countries watered by the Pacific Ocean.

The navigation between the two coasts of the United States has to count on the opposition of the Union and Central Pacific Railroads, which may reduce their present tariff, also the competition of the southern roads, Mexican and Canadian roads, either now completing or constructing. These roads will no doubt be victorious in taking away the products intended for the Mississippi Valley, also the larger portion of the passenger traffic and merchandise of greater value.

In the South, the Amazon will take away to the East the raw materials which the eastern slopes of the Cordilleras furnish; in proportion as the navigation improves on the affluents of that river, which are disposed like a fan, and seem to be expressly destined to gather up and bring to the Atlantic the natural riches of its immense basin, the circle of attraction for the canal will be limited in that direction.

It may be possible that the navigation of the Pacific will have the benefit of the canal, and it is they, by opening a new outlet, will contribute to increase the wealth and develop the commerce in the high valleys of that basin. Between Chili and Buenos Ayres, the railroad of the Andes, when finished, may take away some of the Chilian custom. But as a compensation, the railroads on the Pacific coast will raise up on the plateau of Peru and Bolivia, or who will cross the coast chain of Columbia, will bring there their freight.

To the west of the Pacific the Suez Canal will no doubt maintain the monopoly of transportation from the Orient of Europe. It will not give up to its younger brother but the portion belonging to the United States.

VI.—Commercial Resources which the Canal may Develop.

The Suez Canal has revived Aden, which in ancient times was a flourishing port and which was ruined by the discovery of Cape Good Hope and the conquest of Albuquerque; and the opening of the Canal made of Bombay a more important town than of Calcutta.

The interoceanic canal will produce similar effects. It will not revive any old towns, as it will not bring back, like the Suez Canal, the commerce, by the efforts of modern genius, into a route from where the genius of the fifteenth century has discarded it, but it will open a new route in a relatively new country.

No doubt Australia will be profited, and Sydney and Melbourne will grow more rapidly still than they have done heretofore.

New South Wales has plenty of coal. She will mark out the route in establishing depots for the supplying of ships. The Fiji Islands, the Samoan Islands, and Tonga, Tahiti, Marquesa, Galapagos Islands, are in the same position as New South Wales.

England, from where the ships leave sometimes with an incomplete cargo, will be carried, almost without steam by the trade winds, will strongly aid New South Wales in the supplying of the depots with coal.

The old oriental world will also draw its profits, which will be gathered up by the strongly organized markets, like Shanghai and Tokio. It will have one of its deposits at the Sandwich Islands, where the United States and England can bring coal in abundance.

On the American coast there will be a market, which will probably be more benefited than any other on the Atlantic from the day the canal is opened. This market is San Francisco; it will attract a considerable portion of the new traffic, and will become the principal depot of the two worlds on that ocean, as it already possesses the great preponderance by its population, by its capital, and by its fleet, and is backed up behind by a rich agricultural and mining section, unsurpassed by any country on our great terrestrial globe.

The large valleys of California, Oregon, allow to harvest an abundance of grain, 13,000,000 hectoliters in 1876 (1 hectoliter=2⅞ Winchester bushels); barley fruits, a production of over 500,000 hectoliters of wine (1 hectoliter, 26½ gallons), and can furnish 25,000 tons wool. This production surpasses the needs of a population which counted about 600,000 souls in 1870, and will give, as soon as new markets are opened, a more considerable exportation, which in itself will require a more abundant production. The lumber of California cannot find a market to-day on the Atlantic coast, but it will with a canal at Panama.

Oregon, Washington Territory, and the islands which border the coast from Vancouver to Mount Fairweather, and which the abundance of the rains has covered with thick forests from the summit of the mountains to the shores of the ocean, will enjoy the same advantage, and this article alone will furnish a great many tons.

The fisheries in the north may become more active, and the Russian Asiatic coast will be benefited thereby as much as the American coast.

Central and South America will find more accessible markets for their products, and will be solicited to develop their agricultural riches. "The opening of an interoceanic canal," says Mr. Peralta, "will develop these resources in an extraordinary manner, very difficult to foresee, this development being subordinate to the European immigration, which this great enterprise will not fail to bring forth to these privileged regions as well in capital as in men."

Peru and the neighboring states will find for the growth of the sugar culture, for the production of grain, fine wools, also for the exploitation of their forests, their guano and nitrate deposits, such facilities which the present state of commerce does not afford as yet.

The Atlantic coast will also have its share. The Antilles will be the first on the route; they will be benefited by the food and the materials of construction of the North American coast. Cuba, the richest of the Antilles Islands, will find new sources of prosperity. Havana is among the ports which ought most desire the opening of the canal. St. Thomas will remain an important station, being a point where several routes meet; and Martinique will also see its port prosper, which is the largest and safest of the smaller Antilles. The Island of Hayti will also have points of rest to offer on the now routes; the harbor there is well protected. Curaçao also offers some advantageous points, on account of its position and salubrity of climate; and the Dutch marine will probably make of it one of its depots on the East India route.

In South America Brazil has also a great interest in the cutting of the canal. In the northern portion of the Gulf of Mexico, New Orleans will have in consequence an outlet to the two oceans, and the valley of the Mississippi will receive directly the products of the Andes.

We do not wish to insist on the advantages which the Atlantic American coast and the western European coast will derive from it. It is self-evident that the commerce between the two oceans cannot grow on the shores of the Pacific, but in proportion to the growth on the Atlantic shores. Commerce is an exchange: we have to give first before we can expect anything in return, and every one gains on that which he acquires in exchange of that which he gives up. It means a double profit. It is certainly easy to see the progress which will result from the union of the two oceans and of the continual circulation established around the globe in the northern hemisphere; and as we have undertaken to make a calculation up to the date when the canal will exist, because under analogous economic conditions, the past once established, can serve as a measure for the future, and the results which have been presented are a simple approximation, founded on certain probabilities, and of which we give the following *résumé:*

"In ten years, at the time when the canal will be opened to commerce, 5,250,000 tons will represent the commercial movement of the two oceans, and 2,000,000 tons will represent that portion of the commercial movement between the Orient and Europe which may be taken away from the old routes and take the way of the American isthmus—a total of 7,250,000 tons.

We must not be mistaken in the reach of these figures. They do not signify that 7,250,000 tons will take the route of the canal the year of its opening or the following. We have to establish a distinct line, in the point of view of probabilities, between a current which exists and a current which has to create itself; and we apply the last 2,000,000 tons to this current to be created. We will go even further, and say that the current which exists already, and which, if no extraordinary perturbation modifies the economic movement in the interval, will at a moderate valuation amount to 5,250,000 tons in 1886 and not enter entirely into the canal.

It will come into the province of the canal to attract its own customers and to increase from year to year its own traffic, which will grow in proportion as it will assist the increase of wealth and production of those countries which it will bring in closer contact. We can add here that the canal has the double advantage, by allowing a continuous transportation without reloading, and offers the shortest route.

We have to add here that we have taken the net tonnage and not the gross tonnage in our calculations, which makes a difference of one-third on the gross tonnage of steamships, one-half on sailing vessels, and is a consideration which has been voluntarily neglected, but is not indifferent as to the revenue of the canal.

As far as the revenues are concerned—it is a natural question, when a new route, railroad, or canal is projected,

to ask—What will it pay? It is always a problem hard to solve, especially with a new route like a canal. Who would have explained the question of revenue of the Suez Canal when, thirty years ago, its author first entertained the idea? The first builders of railroads, did they imagine what movement they are going to create and what their income is going to be?

The railroads and steamboats are inventions which have changed in our century the whole face of the economic world, not by the dividends they have distributed, but by the riches which they have indirectly created in bringing nearer great distances and facilitating the outlets.

And in creating these riches the canal will eventually get his pay and a large income. Certainly the great transformations in our means of transports, canals, steamers, railroads, which our century has seen accomplished, are eminent services to humanity, and mankind ought to be thankful for these creations, and all nations ought to bring their aid and support to the accomplishment of this great work.

ON THE TREATMENT OF STEEL FOR THE CONSTRUCTION OF ORDNANCE AND OTHER PURPOSES.

By SIR W. G. ARMSTRONG, C.B., F.R.S.*

THE improvement which of late years has been effected in the manufacture of steel, and the control which has been attained over the quantity produced, now seems to justify its exclusive employment in the construction of ordnance. We have, therefore, to consider what are the conditions under which it can be most favorably used for that and other purposes.

There is at present much want of a proper definition of steel. The former was formerly confined to iron containing a much higher proportion of combined carbon than is found in the so-called mild steels of the present day. The chief distinction between iron and steel now seems to lie in the process of manufacture, steel being operated upon in a state of fusion, while iron is dealt with in a state of agglutinization. But even in the mild state, steel, as thus defined, contains more carbon than is generally to be found in wrought iron, and this excess, small as it is, appears to exercise a very important influence upon its qualities. These qualities have been very distinctly brought out in some investigations which I have recently had occasion to make on the welding, tempering, drawing, and annealing of steel, and the results possess a general interest, independently of gun-making. First, as to the adaptation of steel for welding. As a matter of everyday practice, we know that steel very low in carbon is capable of welding, and it has frequently been maintained that without departing from the system of constructing ordnance known as the "civil system," great advantage would be realized by substituting mild steel for wrought iron in the making of welded coils. Our distinguished president, who has taken such a leading part in the modern development of steel manufacture, and whose knowledge of the metallurgy of the subject is not surpassed by that of any other person, has held this opinion, and a few years ago he supplied to my firm a sample of mild steel specially prepared for this purpose. It was very low in carbon, containing only about 0·10 per cent. A test piece cut from the bar as it came from the maker showed the limit of elasticity, or point at which permanent stretch commenced, to be 13·5 tons per square inch, being not much greater than that of wrought iron, and it broke at 23·3 tons, showing that its ultimate strength was also very similar to that of iron; but its ductility was so great that it stretched to the extent of 37·5 per cent. of a length of 2 inches before breaking. A similar test piece tempered in oil had its elastic limit raised to 24 tons per square inch, and it broke at 28·6 tons per square inch, while its ductility remained nearly the same as before, the elongation being 36 per cent. instead of 37·5. It will be perceived, therefore, that the material was of a very fine quality, and if the results attained with the tempered specimen could have been realized in a welded coil, its superiority over wrought iron would have been very marked indeed. Two welded coils of equal dimensions were made from this material, and there was no appearance in either case of defect in the welding. Both of these coils were tempered in oil, and one of them was applied as a jacket to a steel cylinder closed at both ends, and used for the purpose of determining the pressure exerted by different charges of gunpowder fired in confinement. An exact duplicate of this cylinder was jacketed with a coil of wrought iron of the same dimensions as the steel one, and the two cylinders were used in comparison with each other. Much to our surprise, the cylinder with its steel jacket began to stretch laterally under a pressure which produced no change in the wrought iron coil. The experiment was considered conclusive against the use of steel for welded coils, and no further attempt was made to use it for that purpose.

The duplicate of this steel coil was laid aside, and my attention having been lately recalled to the subject, I applied myself to discover the cause of the inferiority displayed after undergoing the process of coiling and welding. I had a test piece cut from the coil in the lengthways direction of the bar of which it was made, and I found the elastic limit was only 12·5 tons per square inch, against 24 tons in the previous tempered test piece, while the breaking point was 19·1, against 28·6 tons in the former case. The loss of ductility was still more decided, the elongation being only 7·5 per cent. instead of 36 per cent. I then had a test piece cut across the welds, and this broke, not at a weld, but through the solid, thus showing that the welding was perfect. In this case the elastic limit was 12 tons per square inch, the breaking point 20·1 tons, and the elongation 6 per cent. To determine whether the deterioration which the material had sustained was permanent, or whether this quality could be restored, a portion of the welded coil was hammered out in length, and reduced from a piece of about 5 inches and 2 inches thick to a section of about 1 inch square. A test piece from this bar showed a complete restoration of the fine qualities of the steel. The limit of elasticity rose to 21 tons, the breaking point to 27 tons, and the elongation to 36·5 per cent. It was remarkable, however, that after this treatment no further increase of strength was obtained by a renewal of the tempering process. The fracture of the test piece from the original bar was slate colored, and of the character usually called fibrous. The test pieces from the coil shown in coursely granular fracture, but in the restored state, effected by hammering, the fracture again became slate colored and fibrous. Thinking it possible that the coil might have been over-heated in the welding process, I had a pile made with a number of small slabs of the restored material, and welded at a somewhat lower heat than had been applied on making the coil; but test pieces cut across the pile invariably failed at the junctions with a very insignificant strain, showing that the welding heat could not be reduced consistently with sound welds.

In order to ascertain whether it was the heating or the hammering that had injured the welded coil, I had a piece of the material cut from the coil and restored to a good condition by drawing under the hammer, and then heated up to the welding point, allowed to cool without being hammered for welding. In this case the fracture showed no change of crystalline structure, nor was there any decided alteration in quality except that the hardening effect of the hammering was removed. It began to stretch at a low limit, viz., 12·5 tons per square inch, but its breaking point was 25·2, which was higher than in the original bar. The elongation remained nearly the same, being 34 per cent., so that the mere heating to a welding temperature without disturbing the particles by hammering had no serious detrimental effect. I then took a piece of the steel in the restored condition, and after heating it to the welding point, delivered upon it in that state a single blow of a hammer sufficient to crush it into half its thickness. The result was that the flattened piece divided into fissures all round the edges. For the purposes of comparison I took a piece of wrought iron, selected at random from a scrap heap, and treated it exactly in the same manner. The result was that the iron bore the blow, flattening it to the same extent as the steel without showing the slightest fissure on its edges. These two pieces are now on the table, and it is impossible to examine them without perceiving that the steel, though differing so little from iron in the amount of its carbonization, was yet, when heated to the welding point, in a state of friability, while the iron remained perfectly plastic. The conclusion was thus confirmed that it is the disturbance of the particles in this friable state, and not the more heating, which exercises the injurious effect in the welding process. I was not surprised to find that the coil itself had derived no benefit from the tempering, because although steel so low in carbon as this sample is considerably improved by tempering when the piece subjected to the process is of small dimensions, yet when the bulk is considerable the cooling in the oil is not sufficiently rapid to produce any decided effect.

My next experiments were made upon a block of gun steel, containing 34 per cent. of carbon, and which had been rejected on account of its deficient tensile strength. A test piece, cut from the block as received from the maker, began to stretch permanently at 11 tons per square inch, breaking at 29·4 tons per square inch with an elongation of 24·25 per cent.; but a piece of the same steel drawn out under the hammer at a red heat from a thickness of 5 in. to a thickness of 1¼ in. resisted 19 tons, instead of 11 without stretch, and a breaking strain of 27·5 against 24·25. A piece of the same steel 5 in. long by 4 in. thick, having been tempered in oil, gave a test piece showing a further increase of strength with little diminution of ductility. It began to stretch at 23 tons, breaking at 36·5 tons, and elongating 21 per cent. Various attempts were made to weld this steel in a pile of slabs, but it was found impossible to make sound joints, and the steel was even more deteriorated than had been the case with the previous sample; but a piece of this material spoiled in the attempt to weld it, having been drawn out into a bar of 1 in. square, proved to be far stronger than in the original state. It stood 24 tons per square inch before stretching, against 11 tons in the previous untempered state, and 33·6 tons before breaking, against 29·4, but the elongation was reduced from 24·25 per cent. to 15 per cent. The fracture in this case was of the same character as in the original piece, and showed no indication whatever of the previous injury it had sustained by the attempt to weld it. A piece of the same ingot, heated to a welding temperature, and allowed to cool without hammering, gave a test piece which, so far from showing any injury by the heating, resisted a considerably higher strain than the sample taken from the block as it came from the maker. Its stretching point was 16 tons per square inch, its breaking point 33·2 tons, and its elongation 20 per cent. Another block of gun steel containing rather more carbon, viz., 0·41 per cent., gave the following results: A test piece, cut from block in its original state, began to stretch at 14 tons per square inch, broke at 32·5 tons, and elongated at 23 per cent. The same cut from a thick lump of the same material, which had been tempered in oil, resisted 28 tons before permanent stretch and 43 tons before breaking, with an elongation of 16 per cent., thus showing the much greater effect of the tempering process; the proportion of carbon is increased, but showing also that the loss of ductility by process becomes more considerable.

It being important to ascertain whether steel cylinders which have been tempered in oil could be reheated sufficiently for the purpose of shrinking upon a gun without destroying the effect of the tempering, a test piece, cut from the same tempered lump of this steel, was heated in melted zinc to a temperature of 750° and then allowed to cool naturally in air. Comparing its resistance with the piece which had not been reheated, it gave 25 tons per square inch, against 28 tons before stretching, 40·2 tons against 43 tons before breaking; but its ductility was increased from 16 per cent. to 20·5 per cent.; so that although rendered slightly inferior in strength, it was rendered more ductile and tougher by the reheating. Similar experiments made with steel rather lower in carbon showed that the effect of reheating to this temperature was almost inappreciable either in the way of improvement or the contrary, and no degree of sudden cooling from so low a temperature had any distinct effect. On carrying the reheating to still higher degrees, the effect of the previous tempering gradually diminished, but was not altogether obliterated, even when the temperature was raised to the bright red heat which the rapid cooling steel had when immersed in the oil. The friability of the steel at a welding temperature became more marked as the percentage of carbon was increased. Of the many examples I tried, the highest in carbon was the block already mentioned containing 0·41 per cent. of carbon. This steel, like the milder samples, suffered very little from being merely heated to the welding temperature, provided that while so heated it was not disturbed by hammering. But it was so friable at that temperature that it broke into a mass of small crumbs under a moderate blow of the hammer. It was remarkable, however, that the same blow of the hammer which detached them from the block united them in a thin cake on the anvil. Specimens are produced illustrating the effects of this treatment. Whether the friability at a high temperature can be corrected by combining these materials with it is a point upon which my experience casts no light. If it can be so corrected without detriment to the material, the knowledge of how to do it will be an important acquisition to metallurgical science.

Many of my test pieces were taken from rolled steel hoops containing from 0·22 to 0·35 per cent. of carbon, and all of these showed much greater tenacity than was exhibited by test pieces taken from forged blocks of similar material. It is one of the characteristics of mild steel that it is enormously increased, both in strength and toughness, by being drawn out either by rolling or hammering, but especially by rolling, which is more uniform in its action than hammering. There can be no doubt that the process of rolling steel tires may be extended to the production of rolled hoops of great width, and the time may not be distant when we may see a realization of the prediction made many years ago by Sir Frederick Bramwell, that we should eventually be able to produce in this manner continuous unwelded cylinders for boiler-making purposes. Steel cylinders thus made and tempered in oil will be in a highly favorable condition for the construction of ordnance, but in order to make them available for longitudinal as well as for lateral strength, it will be essential to have them in much greater widths than existing machines are competent to produce. All ductile metals derive additional strength by being stretched, but steel does so in a pre eminent degree. Roughly speaking, its modulus of elasticity may be taken as equal to one one-thousandth of an inch per foot for every ton per square inch of tension. This measure of elasticity applies equally, or nearly equally, to all kinds of steel, but the range of elasticity becomes greater as the strength is increased. Thus steel that will bear 20 tons with permanent stretch, will retract two two-hundredth of an inch per foot of length on being released from its load; while steel that will bear 40 tons without permanent stretch, will recover four hundredths of and inch per foot on the removal of the strain. So, also, if the weaker specimens which recover only two hundredths of an inch be stretched to apoint at which it will sustain 40 tons per square inch, it will be exactly in the same condition in regard to elasticity as the stronger specimen which bore that load in the first instance—that is to say, its range of elasticity will be doubled. This is a very valuable quality, enabling steel to gather strength as it yields to an important increase of load. As an illustration of the extraordinary strengthening effect of stretch upon mild steel, I may mention that a sample of the steel taken from the welded coil to which I have adverted, and which in its original state showed a tensile strength very slightly exceeding that of wrought iron, sustained a load of nearly 85 tons per square inch measured on the attenuated section of fracture. But much as steel gains in strength by the process of rolling, it gains still more by that of wire-drawing. No form of steel is comparable, in respect of strength and toughness, to that which has been drawn into the form of wire or ribbon; and in the case of its application in that form to the strengthening of a cylinder, it has the additional advantage of admitting of being laid on with a more favorable adjustment of tension than is practicable with a solid hoop of considerable thickness. But even with wire, the best tensional condition for giving strength to a cylinder can only be approximately attained, owing to the fact, which is commonly overlooked, that in bending a wire over a cylinder it is impossible to give the proper degree of stretch to both of its sides. The outer side, having a larger circle to describe, must necessarily undergo greater elongation than the inside; and in fact, unless the wire be laid on at a far higher strain than would be necessary or beneficial in the case of rings, the inside, acting as a fulcrum to stretch the outside, will assume a state of compression, which can only be taken off by expanding the cylinder after the wire has been laid on. The thinner the wire the less will this disadvantage be felt; and for this reason a given area of section is much better in the flat, or ribbon form, than either round or square. Great additional strength is given to steel wire by tempering in manufacture, and the highest strength is attained by passing the wire through the die as a final operation after the tempering process. The effect of this treatment is to put a very hard skin upon the wire, which, though greatly adding to the strength, is unfavorable for bending, and a very slight injury to the surface greatly conduces to fracture. Ductility is of paramount importance in wire that has to be rolled at a high tension on a cylinder, and, for this reason, wire tempered after instead of before finishing is safer, though not so strong. If the wire be thick, judicious annealing, though it lessens the ultimate strain which the wire will bear, raises in a very marked degree the limit of elasticity. I have found that steel wire of about 0·2 in. thick, of great ultimate strength, began to stretch permanently at a tension as low as 25 tons per square inch, while after being properely annealed it would bear 35 tons before permanent movement. The explanation of this curious fact is probably to be found in the removal by the annealing process of the contending state of tension produced by the drawing or tempering on the inner and the outer portions of the wire. This view is enforced by the fact that when the thickness of the ribbon was reduced to somewhat less than half, this advantage of the annealing process almost wholly disappeared, and the wire was simply softened or rendered more ductile. Castings of steel unhammered are improved by being tempered in oil in much the same degree as the forged material. Test pieces from a cast trunnion of steel gave the following results: Before tempering the elastic limit was 16 tons, breaking load 27·8 tons, elongation in 2 in., 7·5 per cent. After tempering E.L., 25 tons; B.W., 37·7 tons; Ex., 12·5 per cent.; showing a great improvement under every head. The quantity of combined carbon contained in this specimen was 0·36 per cent. The objection to the use of cast steel in the unhammered form is that it is liable to unsoundness from air bubbles. This I think ought not to exclude its use for trunnion rings, which, from their peculiar form, can only be very imperfectly forged. The unsoundness from this cause would be greatly mitigated by casting under pressure, as advocated by Sir Jos. Whitworth. There is much less sacrifice of ductility or toughness when increase of strength is obtained by tempering than by increase of carbon; and, in fact, the advantage of tempering in oil is so apparent, both in the case of steel castings and of steel which has been either rolled or forged, that there is strong inducement for engineers to avail themselves of the process for increasing the efficiency of the material in nearly all its applications. The saving of the weight of material necessary for a given purpose would amply repay the cost of the tempering, and in the case of bridges of great span, where the strains are chiefly due to the weight of the structure independent of its load, the economy effected would be far more than proportionate to the increase of tensile strength in the material.

My experiments are not sufficiently extended to enable me to speak definitely as to the best proportion of combined carbon for steel, to which the tempering process is to be applied, but excellent results can be obtained with steel containing 0·35 per cent. carbon. If the masses to be dealt with are thin, less will suffice, and if thick more will be required, but it is quite possible that the mode of applying the oil in the tempering process might be improved so as to render it more efficacious where the bulk of the steel is large.

* British Association, Section G.

MOLECULAR STRUCTURES OF METALS.

It is generally held that although most of the known metals are crystalline, they cease to be so when in a rolled state. Whether this be strictly true or not has never been put to the test, but recent experiments by M. S. Kalischer prove that foils of the metals can be made crystalline under the influence of heat. One result of the change is an increase of their electric conductivity. Non crystalline zinc foil becomes crystalline at a temperature of 150 deg. Cent. Tin and cadmium foils become crystalline at temperatures ranging from 200 deg. to 280 deg. Cent. Iron and copper show traces of crystalline structure when left in contact with nitric or hydrochloric acid, but the best result is obtained when the plates are made the positive electrode for the electrolysis of potassium, or copper sulphate or nitrate. Specimens of brass containing 36 to 66 per cent. of copper showed a crystalline structure when made the positive electrode of solutions of copper sulphate or nitrate. In these cases the electric current does not, in M. Kalischer's opinion, produce the crystalline state, but rather the solvent power of the electro-negative constituent of the electrolyte, for it is observed that metals which do not show any crystalline appearance when corroded by free acids or solutions of salts, do not show it under the influence of the electric current. Lead foil is crystalline; silver foil becomes so when heated red-hot; gold foil exhibits a crystalline structure when heated and then etched with warm aqua-regia. Platinum, as was observed by Phipson, becomes crystalline when warmed with aqua-regia. Bars of copper, brass, steel, bronze, tin, zinc, and cadmium have been carefully observed by M. Kalischer and shown to have a crystalline structure.

BOURDON'S HYDRO-PNEUMATIC MOTOR CLOCK.

As known to every one, curved tubes of non-circular section have the property of contracting when a vacuum is created in them, and of returning to their primary form, by virtue of their elasticity, when air is again allowed to enter them. It will be understood, then, how, by combining them with a pneumatic motor, we may apply them so as to cause them to move the pendulum of a clock regularly.

In fact, in the clock invented by Mr. Bourdon, the part that replaces the escapement is a tube exactly like those employed as motors for metallic barometers; and the power which effects the motion is derived from atmospheric pressure, whose action intervenes at regular intervals of time to cause the pendulum to swing as if it were actuated by an escapement system like those generally employed in clockwork.

The apparatus, to operate effectually, must consist of three very distinct parts:

1. The pneumatic motor which operates by means of water flowing slowly from a reservoir.
2. The flexible tube of elliptical section and its distributer, which, under the influence of a partial vacuum, keeps up the motion of the pendulum.
3. The wheel work of the clock, the dial, the hands, and the gearing which puts the motive tube in connection with the wheel-work.

Fig. 1, annexed, gives a general view of the apparatus, and shows at one side the hydro-pneumatic motor, and at the other the clock and its mechanism. Fig. 2 gives the different details that we shall successively examine.

We may begin with the motor shown in vertical section in No. 4 of Fig. 2. No. 3 of the same figure are details, on a larger scale, of that part of the receptacle to which is affixed the *pneumatic trombe*. This motor consists of a glass vessel, B, provided at its base with a copper socket, B', to which is screwed a copper coupling, B'. From this latter start the following parts:

1. A cock, D, which establishes communication with the clock by means of small tubes running along the walls, and which are nearly as invisible as the wires of electric bells. Experience has shown that from a distance of 200 meters the pneumatic action is transmitted to the clock as readily as from a few meters.

2. A second tube, D', running to a mercury gauge fixed to a support, T. This gauge indicates the degree of the vacuum, whose incessant and regular action constitutes the motive power, and which in this clock replaces the spring or weight that usually moves the train of wheels.

3. Finally, in the prolongation of the coupling is found the small glass pneumatic trombe, E, which terminates in a vertical tube, T, through which the water flows into a waste vessel, carrying with it the water coming through the tube, D. This water, which has served to actuate the pendulums on the different floors of a house, may again on the lower floor be employed effectively. As may be seen, especially in No. 3, the socket, B', has its center traversed by a tube, *b*, of small diameter, the lower extremity of which descends in the middle of the trombe, E, to near the orifice of its S-shaped tube, to empty the water into the latter drop by drop.

On the tube, FF (No. 4), which leads the water into the reservoir, B, is mounted a valve, G, which is connected by a lever, G', with a float, H, that serves to keep the water at a constant height. Finally, a lever, I', with a spoon-shaped extremity, I, and articulated with a second lever, J, actuates a vertical rod, J', that is held in the axis of the tube, *b*, by the guide, K (No. 3). This rod terminates in a platinum wire needle that enters the hole in the tube, *b*, and serves to close it automatically at regular intervals of time.

The operation of the spoon-shaped lever is very simple. The water, coming from a reservoir through the opening in the float valve, G, empties into the spoon, I, which, when it is full, tilts and pours its contents into the receptacle. This motion causes the platinum needle to enter the tube, *b*, when the spoon at once rises, disengages the needle, and frees the orifice that furnishes water to the trombe. The effect of this combination is to prevent any obstruction of the tube should it happen that the feed-water contained any impurities.

The operation of the trombe is as easily explained. The water from the receptacle, B, flows slowly through the tube, *b*, and falls drop by drop into the S that forms the lower part of the trombe, E. These drops of water run into the vertical tube, E', of small diameter, and imprison between them quantities of air nearly triple their own volume, so that the partial vacuum (1-25th atmosphere) produced by the flowing water is kept up with perfect regularity in the tube that terminates in the clock. It will be seen, then, that this trombe constitutes in its simplest form a continuous acting pneumatic apparatus, which is very advantageously applied for keeping up the oscillating motion of the pendulum. The sole conditions necessary for obtaining such a result are (1) that the level of the water in the vessel, B, shall be kept at a constant height, and (2) that the capillary orifice of the tube, *b*, shall always be kept open to the proper diameter.

The application of the float cock fills the first condition, and the lever and spoon and the needle satisfy the second.

No. 1, Fig. 2, gives a part view of the clock, and No. 2 gives the details, on the same scale, of the distributing valve. This latter, which presents considerable analogy in its working with the slide-valve of a steam engine, is designed to alternately open and close, at the proper moment, the orifice that communicates with the trombe, and the orifice that admits air, in order to cause the dilatation and contraction of the flexible tube, just as the slide-valve of an engine gives passage to steam to drive the piston backward and forward.

Instead of opening and closing the orifices by means of a sliding piece, which would absorb power and necessitate frequent lubrication, there are two small bands, *a*, *a'*, of impermeable silk that perform that function. Each of these bands is fixed at one end upon the perforated plate of the distributer, L, and at the other to the extremity of a small lever, *l* and *l'*, whose to-and-fro motion causes the rolling and unrolling of the band in such a way that one of the orifices is always closed while the other is open.

The great advantage that this sort of closing presents is that its working requires, as we have already said, only a small amount of power. In fact, although the band supports on its lower surface a pressure proportional to the section of the aperture that it covers, such pressure is almost entirely annulled at the moment the unrolling of the band uncovers the aperture, because the pressure is simultaneously balanced on the two surfaces, making the stress requisite to raise it almost null.

We have seen how the trombe worked, and how, through it, a vacuum followed by an entrance of air could be alternately effected in the flexible tube, A (No. 1). What occurs, in fact, is as follows:

If we move the pendulum from the vertical in order to give it its first impulse, the axis, *e*, carried along by a forked lever, gives a to-and-fro motion to the membranes, *a* and *a'*, through connecting rods and levers; from whence results the successive opening and closing of the orifices of the distributer. When the orifice beneath the membrane, *a*, opens, the orifice, *a'*, is closed, and a communication then exists of the flexible tube, A, with the pneumatic motor, and a vacuum is created in the distributer, L, as well as in the flexible tube. In this latter, the vacuum, on succeeding the atmospheric pressure, brings about its contraction, thus forcing its extremities to approach each other in such a way that the connecting rods, *c* and *c'*, both act upon the balance, *e*, and give a motion in the same direction. Its axis then describes an arc, and this motion is transmitted to the pendulum and train of wheels. But the membrane, *a*, soon closes the corresponding orifice, and membrane, *a'*, opens its own, and then the effect is opposite. Atmospheric pressure is set up in the distributer as well as in the flexible tube, thus producing an expansion of the sides, and consequently a separation of the extremities, whose rods act in the same way on the balance, but give it a direction contrary to the preceding.

Such is the operation of this clock, which, as it utilizes power derived from atmospheric pressure, is simpler and less liable to get out of order than electric clocks. These

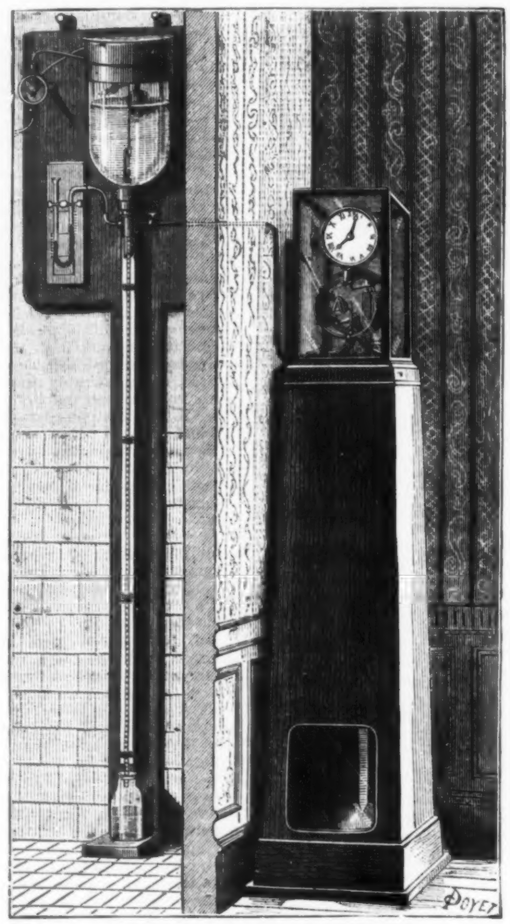


Fig. 1.—BOURDON'S PNEUMATIC CLOCK

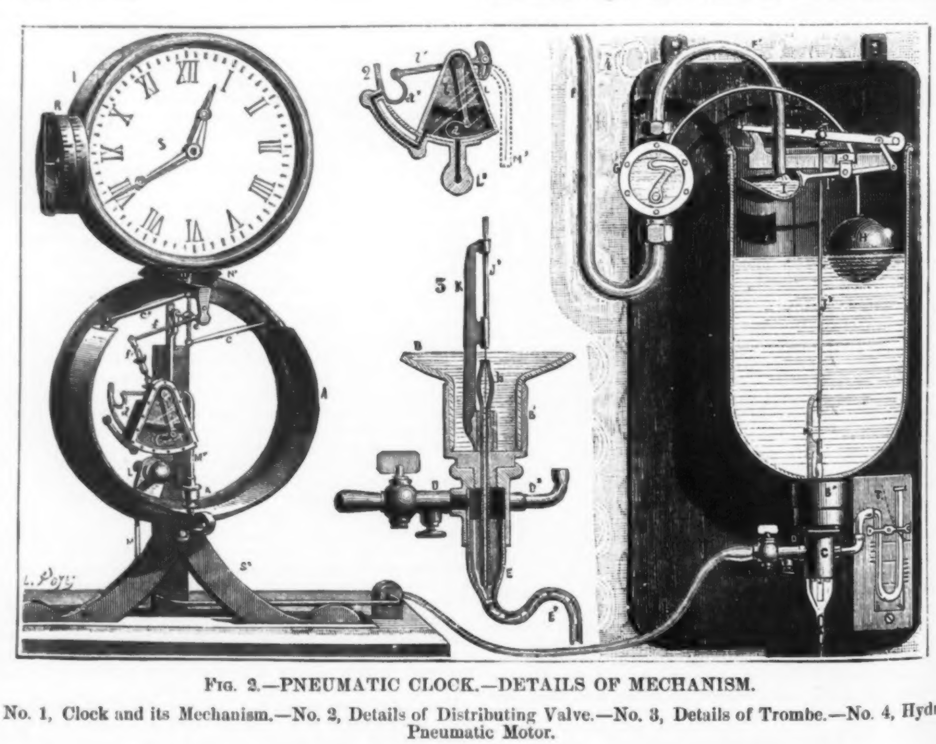


Fig. 2.—PNEUMATIC CLOCK.—DETAILS OF MECHANISM.

No. 1, Clock and its Mechanism.—No. 2, Details of Distributing Valve.—No. 3, Details of Trombe.—No. 4, Hydro-Pneumatic Motor.

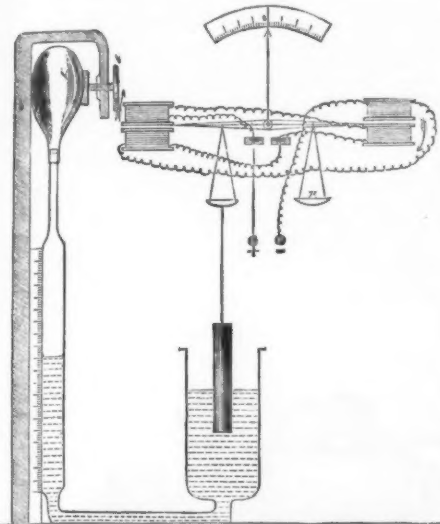
latter, moreover, require for keeping them in running order the use of galvanic piles that have to be frequently renewed, and others necessitate the attendance of persons used to such manipulations.

The expense for motive power is likewise almost null, since the water that keeps up the motion can be taken from almost any source whatever, or from a reservoir regularly supplied by the city mains or by rain water. Finally, the water, whose discharge is only a quarter of a liter per hour, may be collected in a reservoir and saved for household purposes. —*La Nature.*

NEW ELECTRO-DYNAMIC BALANCE.

By M. DEBRUN, Professor at the Lycée de Pau.

THE inventors ought to construct an instrument at once easily worked, sensitive, and exact. The apparatus is composed of a pair of fixed bobbins and a pair of movable bobbins, placed at both ends of a horizontal beam. The current to be measured traverses these four bobbins, arranged



M. DEBRUN'S ELECTRO-DYNAMIC BALANCE.

in circuit in such a manner that the two fixed bobbins repel the movable bobbins placed upon the beam. To protect the system from the action of terrestrial magnetism the beam is placed perpendicularly to the plane of the magnetic meridian. The beam supports two scale-pans, intended to hold the weights, which give equilibrium to the system. The method consists of balancing the dynamic action of the current by weights, until the beam recovers its equilibrium, and the spirals of the bobbins are at the same relative distance asunder.

To avoid the use of weights, which is inconvenient, M. Debrun combined a hydraulic *compensator*, which replaces them. Under one of the scale-pans is fixed a platinum cylinder, dipping half-way into water.

By altering the height of the liquid the pressure is altered. Knowing the diameter of the platinum wire, and the variation of the level of the liquid, one easily deduces the value of the pressure. M. Debrun increases the sensitiveness of the apparatus by making use of a large cylindrical vase, in communication with a tube and a narrow graduated gauge. Equilibrium is restored by forcing the water backward or forward by the aid of an India-rubber bulb, worked by a screw and fixed to the end of it; thus readings are more easily and more exactly taken upon a graduated scale, occupying the length of the gauge. For accurate experiments, M. Debrun brings the balance always to the same position by providing the extremity of the needle of the balance with a net formed of spider's web, and by making use of a micrometer microscope. It is with an apparatus of this kind, divided for the purpose, that M. Debrun has examined the electrical discharges produced by surfaces of mercury vibrating in liquid conductors.

For intense currents, such as those employed for the electric light, M. Debrun replaces the hydrostatic pressure by a spiral spring, which is stretched more or less by means of a graduated screw.—*Proc. French Assn.*

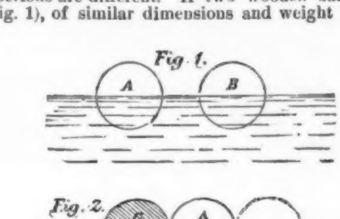
THE HYDRODYNAMIC EXPERIMENTS OF DR. BJERKNES.

ONE of the greatest attractions at the late Exhibition of Electricity at Paris, and at the same time the exhibit which probably more than any other will longest be remembered by the physicist as forming a special feature of scientific interest and novelty, was, says *Engineering*, the series of experimental hydrodynamic illustrations of electric and magnetic phenomena which were shown in the Norwegian Section by Dr. C. A. Bjerknes (Professor of Mathematical Science in the University of Christiania) and his son, Mr. Vilhelm Bjerknes, by whom most of the very beautiful apparatus employed in the experiments were designed.

It is a curious fact in connection with this most interesting research that although Dr. Bjerknes commenced it as far back as the year 1856 by a mathematical analysis of the vibratory motion of one body upon another, or upon a system of bodies within the same medium, it was not until 1875—that is to say, after nineteen years devoted to the mathematical investigation of the subject—that he first tested his deductions by experiments. From the latter date, therefore, commences the experimental portion of the research with which we have more especially to deal in the present notice, but it is due to Dr. Bjerknes to point out that all the more important results of the investigation were arrived at before a single experiment was made, and the experimental has only verified and become a means of demonstrating the results of the mathematical investigation.

If the air within a hollow uniform semi-elastic sphere—such, for instance, as a ball of caoutchouc—be alternately condensed and exhausted, it will alternately become larger and smaller according as air is added or withdrawn, and it is clear that if the substance of the envelope be uniform in thickness, or rather in elasticity, its spherical form will not be destroyed, but it will change from a smaller to a larger sphere, and *vice versa*. If such a ball be surrounded by a fluid medium it is also clear that, while this action is going on, it will alternately displace more or less of the medium in which it is immersed, producing in it a series of pulsations corresponding to its own alterations of volume. These being in directions always normal to the surface of the pulsating sphere—that is to say, in lines radiating from its center—the degree and extent of its influence upon the medium and upon other immersed bodies must obey the law of radial forces, and the intensity of its influence at any one spot will vary inversely as the square of the distance of that spot from the pulsating body, and the lines of force in any one plane will correspond to and be very similar to those radiating from the pole of a single bar magnet, which are so beautifully traced out in the figures produced by scattering iron filings over a sheet of paper or glass, to the under surface of which is presented one pole of a permanent magnet. From the simple conception that a ball pulsating in the manner described must be surrounded by a field of dynamical energy, capable of influencing the medium in which it pulsates, and through that other objects in its neighborhood and immersed in the same medium, Dr. Bjerknes was led to investigate mathematically the nature of the mechanical influences set up by rapidly pulsating and vibrating bodies upon other objects and upon one another, as well as upon the medium in which those influences are at work. From a very early date in the history of his research he came upon results so similar to those connected with magnetism and electricity, that looking at the investigation more and more from the point of view of magnetic and electrical analogy, he pursued the research further and further, more and more confirming his view that the similarities of results, although inverse to one another, were something more than mere coincidences, and indicated a physical connection between the two series of phenomena. To take one of the simplest of the pairs of analogous phenomena, Dr. Bjerknes discovered that if there be two pulsating or vibrating bodies immersed in the same medium, they mutually attract one another if their respective phases of vibration are similar, but if their phases are in opposite direction, repulsion is the effect that takes place between them. Such a discovery would naturally associate itself in the mind of an investigator with the mutual action between electrified bodies, as well as between magnets, although the electrical and magnetic analogues are, or obviously appear to be, inverse to the dynamical phenomena, for attraction takes place between bodies dissimilarly electrified, and between opposite poles of magnets, and repulsion when the electrification or magnetization of presented parts are of the same sign. Mutual inversion, however, of two series of phenomena, so long as they are invariably inverse to one another, contributes but little opposition to the perfection of an analogy, for it is always conceivable that a direct law is being followed, although the phenomena looked at in a particular light appear to be in opposition.

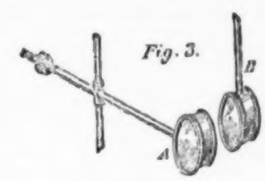
A very simple experiment will illustrate the mutual attraction exercised by two bodies upon one another when vibrating in similar phases of unison, and the reverse effect when their periods are different. If two wooden balls, A and B (see Fig. 1), of similar dimensions and weight be dropped



from a short distance on to the surface of still water, they will, from their inertia acquired by gravitation, first descend to a certain distance below the surface of the water, then in the effort to float will rise above the surface, and will continue thus to vibrate with ever-decreasing amplitude until equilibrium is established; during this process, they will displace alternately more or less water, and in that sense will have a similar effect upon the medium in which they are immersed as if they were alternately distended and contracted, as we have described in connection with the caoutchouc spheres. If the two bodies be equal in size and specific gravity their period of vibration will be the same, and it will be found that immediately after they are dropped into the water, they will be attracted the one toward the other, while if two balls, A and C, Fig. 2, of equal diameter, but of which C, although lighter than the water, is heavier than A, be dropped into the water in a similar manner, the heavier ball will descend below the lighter, pass under it, and rise on the other side, from which it will be repelled.

Dr. Bjerknes's earlier experiments upon the influence of pulsating bodies were made with hollow caoutchouc balls, from which the air was alternately partially withdrawn and restored in rapid succession by a simple form of rapidly reverting pump, which it will not be necessary to refer to here, as we shall in the course of the present article describe and illustrate the more elaborate apparatus by which the first has been superseded, and with which the more recent portion of the investigation has been conducted.

An elastic ball expanding and contracting in the manner described, within an incompressible fluid, such as water, would produce in that medium corresponding vibrations or impulses propagated in radial lines, and the further from the disturbing object the less the particles of the medium would vibrate. It is clear that the influence must decrease as the square of the distance increases, because at twice a given distance the vibrating influence will be propagated over a spherical surface four times as large, and at three times that distance, a spherical surface of nine times the area will be influenced by the disturbing action of the pulsating ball. If such a pulsating ball be presented to a body suspended within the fluid medium, the latter body will, if of less specific gravity than the medium, be repelled by the pulsating ball; but if, on the contrary, the suspended body be heavier than the medium, it will be attracted, and Dr. Bjerknes explains this phenomenon by comparing the influence of the pulsating body upon the medium (irrespective of the neutral body) with that of the medium so affected upon that body. Let us first suppose the neutral body removed, then the particles of the fluid are, under the influence of the pulsating ball, carried backward and forward, the outward motions corresponding to the expansions of the ball and the inward motions corresponding to its contractions. At the end of one complete vibration a particle of the fluid will have made one excursion, and will have returned to its original position, no permanent transposition having been brought about. If now a body of less specific gravity than the medium be lowered into it, it will be influenced very differently to the particle of fluid which we have just been considering, for in consequence of its greater mobility, it will in its outward movement travel to a greater distance than the fluid particle, and will be projected to a quieter portion of the vibrating, or, as Dr. Bjerknes calls it, "hydromagnetic" field. In the return motion it receives an impulse from the inward moving particles of the medium



which is insufficient to restore it to its first position, and at the end of one complete vibration it will have made one outward excursion and one return, but its return-stroke being shorter than its outward motion, it will have suffered a permanent outward displacement, thus presenting the appearance of having been subject to *repulsion*. If, on the other hand, this lighter body be replaced by one heavier than the medium, or if the lighter body be checked in its movements, the reverse action will take place; in this case the body will, under the influence of the pulsating ball, be set into reciprocating motion, but the amplitude of its vibrations will be less than that of the fluid particles. In moving outward, it is not projected as far as the particles of the medium, and at the end of an outward excursion it is left in a more active portion of the vibrating field than those particles, and receives from them in their return-stroke

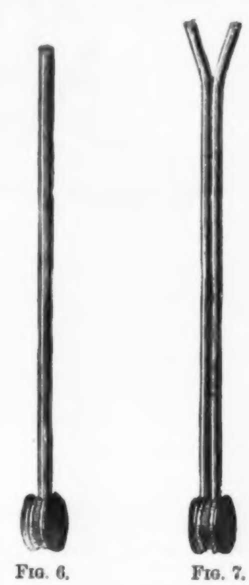
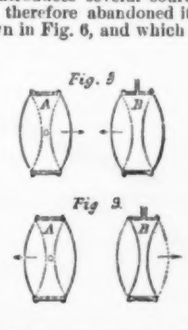


FIG. 6. FIG. 7.

a greater inward impulse than they themselves would have received in the same position. The result is that the body is brought nearer and nearer to the pulsating ball, as if the latter were endowed with *attracting* properties. To this dynamical condition of matter, Dr. Bjerknes has applied the name "hydromagnetism," not intending to imply thereby that any real magnetic influence is produced apart from the vibration of the medium, but because it more conveniently conveys to the mind not only the mechanical effects produced, but also more closely points to their analogy to true magnetic phenomena.

The form of pulsating body represented by an elastic sphere, such as has been described, involves many practical difficulties, and introduces several sources of inaccuracy; Dr. Bjerknes has therefore abandoned it in favor of a pulsating drum, shown in Fig. 6, and which consists of a small



flat metal cylinder about three-quarters of an inch in diameter, with its two circular ends covered with thin India-rubber membrane stretched over the opening, and having a tube communicating with the interior of the cylinder, as shown in the sketch. By alternately forcing in air, and exhausting it from this little instrument, its two sides become alternately convex and concave, and an exceedingly convenient and easily applied pulsating body is produced. We may here state that almost all the very beautiful apparatus which we are about to describe, was constructed by Mr. Andersen, of Christiania, from the designs of Mr. Vilhelm Bjerknes, the son of the author of this interesting investigation, and to whom is chiefly due the practical demonstration of the results arrived at in his father's calculations, and which formed so attractive an exhibit at the Paris Exhibition.

Reciprocating motion, whether pulsatory or vibratory, is

produced in all the apparatus employed by Dr. Bjerknes, by variations of pneumatic pressure, and in Fig. 4 (the following engraving) we illustrate the air-pump by which the alternate exhaustions and compressions are produced. This apparatus consists of two small brass cylinders fixed horizontally upon a wooden baseboard, each of which is fitted with a piston, to which a reciprocating motion is communicated by means of a small crank-pin and connecting-rod attached to a horizontal shaft, that can be rotated at a high velocity by means of a large grooved pulley to which a winch handle is attached. The throw of the crank-pins, and therefore the strokes of their respective pumps, can be varied from nothing to their fullest extent, and by making the pneumatic connection to one or other end of each cylinder, the two pumps may be arranged so as both to be compressing and both exhausting at the same time, or the one may be arranged to compress while the other is exhausting. In all cases each pump alternately exhausts and compresses as the handwheel is rotated.

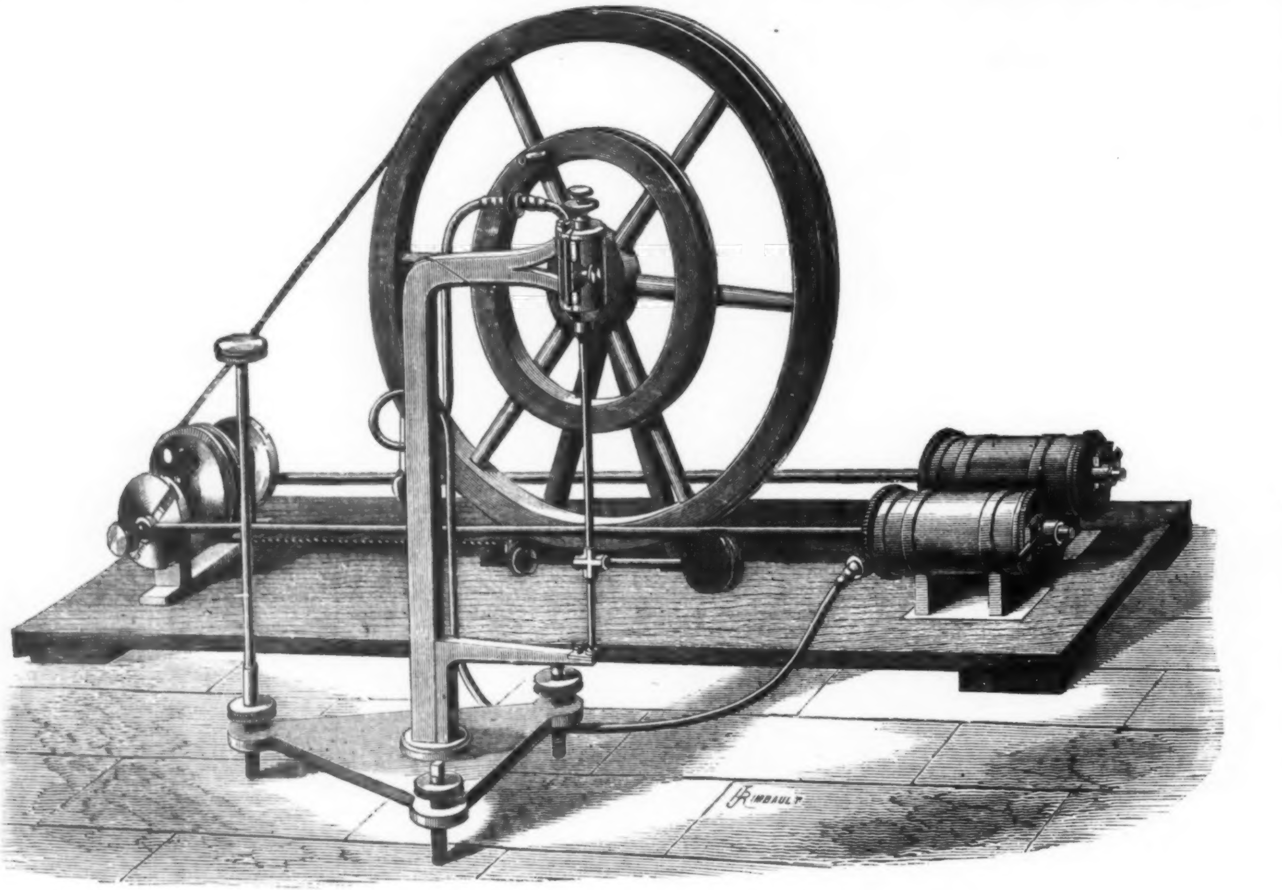


Fig. 4.—BJERKNES'S HYDRODYNAMIC EXPERIMENTS.

In the experiments at Paris, water was the medium in which the phenomena were exhibited, and Fig. 5 is an illustration of the tank employed with one of the most typical of the apparatus immersed in the water. This beautiful piece of apparatus is more clearly shown with its attachment to the pump in the front of Fig. 4. It consists of a pulsating drum attached to the end of a horizontal tubular arm which is capable of rotating, like a weathercock, on a hollow vertical axis by which the whole system, and therefore the interior of the pulsating drum, can be connected by a flexible tube with the reciprocating pump. The vertical axis of this instrument is centered between needle-points, and by means of an exceedingly ingenious device at the top of this axis the varying pneumatic pressure is communicated to the drum without stuffing-boxes and without adding to its frictional resistance to motion, the whole of the movable system turning as easily as a compass on its center.

If this apparatus be placed in the water and connected to one of the pumps, and the pulsating drum (Fig. 6) be connected to the other pump, it will be found, on presenting the latter to the movable drum after the manner illustrated in the diagram, Fig. 3, and rotating the pump-wheel, that when both pulsating drums are expanding and contracting simultaneously, the movable drum, A, will be attracted toward B, which effect is illustrated by the diagram, Fig. 8, the arrows showing the direction in which each is urged by the vibrating influence of the other. If, however, the one drum is expanding at the moment that the other is contracting—that is to say, if one be convex when the other is concave, repulsion will take place, and the movable drum will be driven away by the other in a manner precisely similar to that in which one end of a compass needle is repelled if a magnet pole of the same sign is presented to it. By employing a double drum, such as is shown in Fig. 7 (see preceding page), the analogy of the effect of a bar magnet upon a compass needle is still more strikingly illustrated. This drum is divided by a central rigid diaphragm into two chambers, each communicating with a separate hollow stem by which it can be connected to one or other of the pump nozzles; by connecting this pair of stems to the two ends respectively of the same pump, and the rotating drum apparatus to one end of the other pump, attraction and repulsion can be illustrated by presenting one or the other of the faces of the double drum toward the rotating instrument, thus illustrating the effect of the two poles respectively on one end of a compass needle.

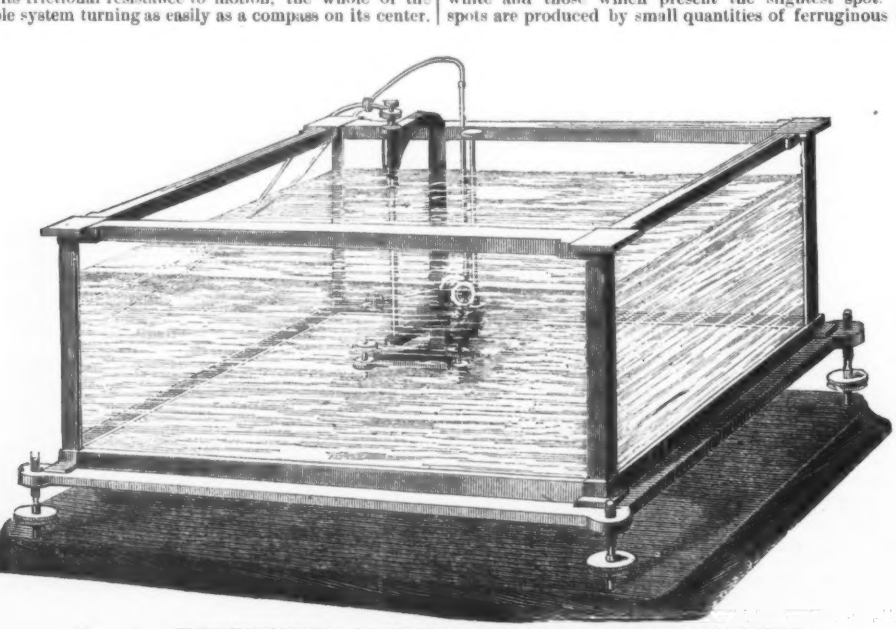


Fig. 5.—BJERKNES'S HYDRODYNAMIC EXPERIMENTS.

PURIFICATION OF PORCELAIN.

There is a difference in commercial value of forty per cent. between pieces of porcelain which are absolutely white and those which present the slightest spot. The spots are produced by small quantities of ferruginous matter, of which the chemical composition is not well known, but which can be attracted by a magnet. Many attempts have been made to use magnets systematically, but they have hitherto been unsuccessful. Two French establishments have lately employed the following method with very satisfactory results: Each electro-magnet is composed of two coils placed in a line; their remote ends are connected by a long piece of iron; the two near ends are but a short distance apart, one representing the north pole and the other the south pole of the electro-magnet; between them there is a magnetic field which can be made very powerful, provided there is a sufficient exciting current. A tight box incloses this magnetic field; it is open above, and has a round opening below into which an escaping tube is inserted. The porcelain paste, very liquid, running into the box, encounters a small zinc diaphragm which sends it to the right and to the left over the polar faces; the magnetic particles are retained and the rest escapes. The polar surfaces are cleansed twice a day by a jet of water. The apparatus may be worked either with a Gramme machine or with a battery.—*L'Electricien.*

THE PROCESSES OF MM. A. CLASSEN AND A. VON REISS FOR THE DETERMINATIONS AND SEPARATIONS OF METALS BY THE ELECTROLYTIC METHOD.

Report by V. Francken.

Since the discovery of the process for the electrolytic determination of copper, various chemists have sought to utilize this simple and elegant method for the determination of other metals. While in the attempts made hitherto the separation of copper succeeds best in a nitric solution, an ammoniacal solution is employed for the precipitation of nickel and cobalt, and a solution in potassium cyanide for zinc and cadmium. The exactitude of the results depends on strict observance of the conditions, which we shall explain.

For instance, the precipitation of copper gives quantitative results only, if the proportion of nitric acid in the solution is exactly that which has been established; the precipitation of cobalt and nickel is successful only if a determinate quantity of ammonia and ammonium sulphate has been employed. The electrolytic solution of the chlorides has not been hitherto directly practicable, so that it was first necessary to transform them into sulphates. Except the well-known separation of copper from the metals which are not precipitable in a nitric solution, and from those which are conveyed to the opposite electrode in the state of peroxides, the electric current has not yet been applied as a means of elimination in quantitative analyses. As will be seen below, copper, zinc, nickel, cobalt, iron, manganese, bismuth, tin, cadmium, whether existing as sulphates, chlorides, or nitrates, may be precipitated much more quickly and simply than they have been hitherto, and some of these metals may also be separated in one and the same solution.

DETERMINATION OF COBALT.

If we add to the solution of a salt of cobalt an excess of neutral potassium oxalate, and if the clear solution of oxalate is submitted to electrolysis, the intense red color soon passes to a deep green, which becomes gradually feebler as the cobalt is deposited in the metallic state at the negative electrode. The potassium oxalate is converted into carbonate by the current, and by degrees there is deposited along with the metallic cobalt a precipitate of cobalt carbonate. This precipitate is dissolved by adding cautiously oxalic or dilute sulphuric acid, and the whole of the cobalt is separated by the continued action of the current until the liquid again becomes alkaline.

The electrolytic separation of the cobalt proceeds much

more rapidly if the potassium oxalate is replaced by ammonium oxalate, which forms with the compounds of cobalt a double salt readily soluble, and if care is taken to add merely as much ammonium oxalate as is necessary to form the double salt of cobalt. There is deposited along with metallic cobalt a red insoluble cobalt oxalate, which is only slowly reduced by the current. To prevent this separation, the liquid, to which has been added ammonium oxalate in excess, is heated, and 3 to 4 grms. of solid ammonium oxalate are further dissolved. The boiling solution, when exposed to the influence of the currents, deposits the cobalt in the form of a gray adhesive coating. By this process, with two Bunsen elements, about 0·2 grm. of cobalt may be separated in the course of an hour. When the reduction is complete (which may be ascertained most simply by adding ammonium hydrosulphate to a small sample of the liquid taken out with a capillary tube), the positive electrode is withdrawn from the liquid which is decanted off, and the precipitate is washed several times with water, then with alcohol, and finally with absolute ether. The residue of cobalt is then dried in an air-bath at 100°, and in a few minutes gives a constant result.

DETERMINATION OF NICKEL.

We proceed precisely as in the determination of cobalt—*i.e.*, we add to the solution ammonium oxalate in excess, heat, and add further about 4 grms. of the solid salt. The separation of nickel is effected as rapidly as that of cobalt; the nickel is deposited in a gray compact stratum, which remains firmly attached to the electrode.

DETERMINATION OF IRON.

The authors have used in these assays a solution of chloride and a solution of sulphate, and have proceeded exactly as above. The electrolysis goes on perfectly without separation of any compound of iron if there is present a sufficient quantity of ammonium oxalate. The iron separates out in a brilliant mass of a steel gray color firmly attached to the platinum. The reduced iron may be exposed for days to the air without any perceptible oxidation.

DETERMINATION OF ZINC.

Zinc is separated from its solution as a double salt as easily and as rapidly as the preceding metals. The reduced zinc has a dark-gray color, and remains very firmly attached to the electrode. The separated metal cannot be dissolved by heating with dilute acids; in general it appears as a dark coating, which can be detached only by heating the capsule to redness, and treating the residue afresh with acid.

DETERMINATION OF MANGANESE.

It is known that manganese can be separated as peroxide from a solution to which nitric acid has been added. But, according to the author's experiments, the precipitation is complete only when the quantities employed are small, when but little nitric acid is used, and when the rinsing takes place without interruption of the current. If the manganese is converted into a soluble double compound by the introduction of an excess of potassium oxalate, and if the solution is then electrolyzed, all the manganese is precipitated at the positive electrode. If ammonium oxalate is employed, the precipitation is not quantitative. The peroxide separated is not firmly attached to the electrode. Hence it is separated by filtration and transformed into Mn_3O_4 by heating.

DETERMINATION OF BISMUTH.

This assay presents some difficulty. We do not succeed in separating the metal as a compact mass adhering to platinum, and the bismuth is always obtained in the same state whether it is precipitated from an acid solution, from the solution of a double salt of ammonium and of oxalic acid, or from a solution to which potassium tartrate has been added. If we give the platinum the greatest possible surface, and fill the capsule to the brim, we may, with a small quantity of bismuth, effect the rinsing in water, alcohol, and ether without loss. If in this operation particles of metal are detached from the capsule, they must be collected on a weighed filter and determined separately. In these assays we add to a nitric solution of bismuth a sufficient excess of ammonium oxalate. In the electrolytic decomposition we observe at the positive electrode a precipitation of peroxide, which slowly disappears. To preserve the reduced metal from oxidation it is necessary to remove the last traces of water by an abundant washing with alcohol and anhydrous ether.

DETERMINATION OF LEAD.

In a nitric solution lead behaves like manganese. When the quantity of peroxide separated is so considerable that it no longer remains firmly attached, and when it passes mechanically to the negative electrode, we cannot effect the determination without considerable loss resulting from the re-solution of the peroxide. The results are very uncertain.

If we submit the double oxalate to electrolysis, all the lead present is indeed deposited in the state of metal, but it is so quickly oxidized on exposure to the air that it is rarely possible to dry it without change, even in a current of coal-gas. The electrolytic determination of this metal cannot, therefore, be recommended.

DETERMINATION OF COPPER.

Copper is separated very rapidly and easily from the double salt which it forms with ammonium and oxalic acid, if only a sufficient quantity of ammonium oxalate is added. Weak currents cannot be used for the determination of considerable quantities of copper, as in this case the metal does not attach itself firmly enough to the electrode. The authors employ a strength of current corresponding to about a development of 330 c. c. of gas hourly, and can separate 0·15 grm. metallic copper in about twenty-five minutes.

DETERMINATION OF CADMIUM.

If the double oxalate of ammonium and cadmium is electrolyzed, we obtain the cadmium in the form of a gray coating, which, though not adhering very firmly to the electrode, undergoes no loss if washed with caution.

DETERMINATION OF TIN.

Tin can be very well determined electrolytically. It separates either from a hydrochloric solution or from the solution of a double ammonium oxalate in the state of a fine gray coating. If we use the potassium salt instead of ammonium oxalate, the electrolysis presents difficulties, for there appears at the opposite pole a basic salt which is not reduced. If the tin is separated from an acid solution the current must not be interrupted during rinsing—a precaution not necessary when employing the ammonium oxalate. When the tin is detached from the platinum capsule it presents phenomena similar to those described under zinc. As a general rule, there remains a black residue on the electrode.

DETERMINATION OF ANTIMONY.

In a hydrochloric solution, antimony is precipitated in the metallic state, but not firmly attached. If to the solution of trichloride we add potassium oxalate the antimony is easily reduced, but the metal is still not attached firmly to the electrode. A firmly adhesive coating may be obtained by the addition of an alkaline tartrate, but the separation takes place too slowly.

The precipitation of antimony succeeds very well in a solution of its sulpho-salts. We add hydrogen sulphide to the solution, which may contain free hydrochloric acid; we neutralize with ammonia, and add ammonium hydrosulphate in excess. The reduction is accelerated by the addition of a little ammonium sulphate. The antimony is separated at the electrode as a fine light gray precipitate, firmly attached if the precipitation has not been hastened by the use of too strong a current. When the reduction is complete the liquid is decanted off, and the residue cleaned in the ordinary manner.

DETERMINATION OF ARSENIC.

Arsenic cannot be separated quantitatively either from an aqueous or a hydrochloric solution, or from one to which ammonium oxalate has been added.

In the aqueous solution, as well as in the oxalic, a part of the arsenic is reduced to the state of metal, while in the hydrochloric solution it is all volatilized as arsenamine if the action of the current is sufficiently prolonged.

SEPARATION OF IRON AND MANGANESE.

The separation of the two metals is only possible by preventing the formation of manganese peroxide until the greater part of the iron has been precipitated. We effect this object by the addition of sodium phosphate, or more easily by the addition of a large excess of ammonium oxalate.

In both cases there appears, under the influence of the currrent, the characteristic coloration of permanganic acid, which disappears afterward at the negative electrode. When the greatest part of the ammonium oxalate has been transformed by the current into ammonium carbonate, the color becomes permanent in consequence of the formation of manganese peroxide. We add, in the outset, ammonium oxalate to the liquid, apply heat, dissolve further 3 or 4 grms. ammonium oxalate in the liquid, and electrolyze at once. The separation of the two metals takes place immediately and exactly, especially if the quantity of manganese is small. It appears as peroxide at the positive electrode, while the iron is deposited at the negative. If the proportion of the manganese is more than double the quantity of the iron, the precipitation of the latter will last longer. It is then necessary, in order to effect a complete separation, to re-dissolve the deposit of peroxide in oxalic acid, adding the latter without interrupting the current, so long as the liquid has a red color.

In separating the two metals the authors find it useful not to apply too strong a current (2 Bunsen elements are sufficient), and not to re-enforce it unless compelled in consequence of too large a quantity of manganese, so as to redissolve the peroxide. When the assay is concluded, it is not prudent to let the current act, as then a little peroxide is deposited very firmly upon the iron, and must be dissolved off in oxalic acid, after decanting off the liquid, or the electrolysis must be repeated. As we have already remarked in treating of the determination of manganese as peroxide, the precipitation of this metal from a solution of ammonium oxalate is not quantitative. We must, therefore, boil the liquid which holds in suspension the greater part of the manganese in the state of peroxide, so as to decompose the ammonium carbonate. The rest of the ammonia is then neutralized with nitric acid, and the manganese is transformed into sulphide by the addition of ammonium hydrosulphate. The manganese sulphide is strongly heated in a current of hydrogen and weighed directly.

SEPARATION OF IRON AND ALUMINUM.

This separation, which offers serious difficulties by the ordinary methods, is easily effected by electrolysis. If we submit to electrolysis a solution (of ammoniacal oxide of iron and of aluminum ammoniaco-oxalate), to which a large excess of ammonium oxalate has been added, the iron is separated first as a coating firmly attached to the negative electrode, while the aluminum remains in solution as long as the quantity of ammonium oxalate is greater than that of the ammonium carbonate formed. If there is ultimately produced a precipitate of alumina, the solution is then almost entirely free from iron. A few drops of the liquid holding the aluminum in solution are tested from time to time with ammonium hydrosulphate, to find if iron remains and the current is interrupted as soon as no reaction is produced.

To make the determination we add ammonium oxalate in excess to a neutral or slightly acid solution. We may also, if needful, neutralize with ammonia. We add further ammonium oxalate in the proportion of 2 or 3 grms. per 0·1 grm. of oxide, and the hot solution is immediately electrolyzed. The current must not be allowed to act until all the aluminum is precipitated along with the iron. A part of the aluminum would then adhere to the iron so that it could not be detached. Then, as it has been said with reference to the separation of manganese, the iron must be redissolved in oxalic acid, the liquid containing the aluminum having been previously decanted and the electrolysis repeated.

In order to precipitate completely the alumina from the liquid which has been freed from iron, we add ammonia, heat for some time, and proceed in the ordinary manner. If the quantity of alumina is not greater than that of iron, this method gives immediately accurate results. In the contrary case the precipitate of aluminum is dissolved and electrolyzed again, adding oxalic acid cautiously, and not interrupting the current.—*Revue Universelle des Mines.—Chem. News.*

ANTISEPTIC COLOGNE.—The following is commended as a preparation combining antiseptic properties with a perfume:

Eau de Cologne	8 fl. oz.
Chloral hydrate	2 drachms
Quinine (alkaloid)	10 grains.
Carbolic acid (pure)	30 "
Oil of lavender	20 drops.

This may be used on the handkerchief, the doctor holding it gently to the mouth while in the sick room. Warranted to keep out bacillus tuberculosis; also b. termo, b. elephantiasis A., and b. gonococci.

ALCOHOL AND ITS EFFECTS.

By Rev. L. J. TEMPLIN.

THE earliest authentic account we have of the use of intoxicating liquors as beverages is in the case of Noah, who, it is said, planted a vineyard and became drunken on the wine made from the fruit thereof. From that time down we have frequent accounts of the use and effects of various kinds of intoxicating liquors among many nations and tribes of people. The most common source of these drinks in ancient times was the grape; but the palm tree, pomegranate, and melon have been extensively employed for this purpose in both ancient and modern times. In recent times the various cereals have come into very general use for this purpose. Various other substances, as fruits, milk, etc., are frequently employed for the manufacture of intoxicating drinks. It is only by a process of fermentation that the intoxicating principle is generated, as none of it is ever found in any living substance. In the process of decomposition of any organic substance containing sugar in the presence of water, it passes through three distinct stages; the alcoholic, the acetic, and the putrefactive. It is the business of the brewer and distiller to check the process when it has reached the first stage, and so manipulate their liquor as to prevent any further fermentation. Intoxicating drinks were in use many centuries before any correct knowledge of the true nature of the intoxicating principle was obtained.

The Arabian alchemists discovered that if wine was kept at the boiling point for a few minutes it lost its intoxicating power. The intoxicating principle, whatever that was, had escaped. But this powerful agent was invisible, hence it was regarded as a spirit—the spirit of wine.

About the middle of the eleventh century Avicena caught this subtle agent, and gave it a visible, bodily form. Chemists called it "alcohol." This term comes from two Arabic words, Al, the, and Kahol, a fine, impalpable powder. The ladies of the East were accustomed to employ such powders at their toilet. The term "alcohol" seems to have been applied to any powerful, subtle agent, but its modern use is confined to the intoxicating principle or strong drinks—the spirit of wine. The process by which this agent is developed is now quite well understood. If starch be moistened with water in which a little ferment, as yeast, has been dissolved, and subjected to a temperature of one hundred degrees of heat, it will be changed to grape sugar. But if the temperature be maintained in the presence of a ferment it will be decomposed and its elements separated into carbonic anhydride and alcohol. The gas speedily escapes into the air and the alcohol remains dissolved into the water. By distillation this is separated from the principal part of the water, the remainder of which may be removed by certain chemical processes and absolute alcohol obtained. It was once believed that alcohol was the product of distillation, but it is now known that this process only separates the alcohol that has already been generated by fermentation. The alcohol in general use contains from seven to fifteen per cent. of water. Pure alcohol is a transparent fluid having a specific gravity of 796, water being 1,000. It has a very pungent taste, boils at 170°, and has never been frozen. It inflames at 300°, burning with a pale blue flame, emitting no smoke, little light, but much heat. This agent is a powerful solvent, readily dissolving most of the resinous gums and vegetable extracts. Chemically, alcohol is composed of three gases in the following proportions:

Carbon	51·88
Hydrogen	13·70
Oxygen	34·42
	100

The amount of alcohol that is found in the different kinds of intoxicating drinks varies with the different classes and kinds of liquors. The following exhibits the proportion of alcohol and proof spirits found in the different kinds of fermented liquors:

	Alcohol.		Proof Spirits.	
Port wine	23	per cent.	46	per cent.
Madeira	22	"	24	"
Sherry	19	"	38	"
Champagne	12½	"	25	"
Cider	7	"	14	"
Porter	4¼	"	8½	"
Ale	6½	"	13	"
Small beer	1¼	"	2½	"

From this it will be seen that these drinks contain from one fortieth to nearly one half of proof spirits. The proportion of alcohol found in the various kinds of distilled liquors is—

Brandy	53·39	per cent.
Rum	53·68	"
Gin, common	51·60	"
Gin, Hollands	55·44	"
Scotch whisky	54·32	"
Irish whisky	73·70	"
Common whisky	42·95	"

Of this class of liquors we find from over two-fifths to nearly three-fourths to consist of alcohol. Besides the water mingled with the alcohol there are other ingredients found, especially in the fermented liquors, as the hops in beer, juniper in ale, acids in wine and cider, etc. It is a common opinion that the effects of these various drinks on the human system are modified by the presence of these foreign substances; but it is quite doubtful whether these extraneous substances in the quantities in which they are used ever have any marked effect on the system. The various effects resulting from the use of the different kinds of drinks is more likely the result of the different degrees of dilution with water that characterize them, or of the manner in which they are taken. If taken in considerable quantities at once the effect will necessarily be more marked than if the same quantity is taken gradually so that it may be gradually taken up and disposed of by the system. In treating of the effect of alcohol on the human system no distinction will be made as to the kinds of liquors which contain the alcohol used. These effects are produced by two different processes, a chemical and a physiological one. Its most important chemical property is to arrest and prevent decomposition in all organic bodies, whether animal or vegetable. For this reason it is largely used for the purpose of preserving natural history specimens in the cabinets of scientists. In its antiseptic properties it is excelled only by creosote, carbolic acid, and arseniate of soda; but it has advantages over all these and is more generally used. When taken into the stomach with food it prevents the decomposition of the food under the action of gastric juices, and hence it tends to retard digestion and is detrimental to health.

But as digestion must proceed that life may be preserved,

this evil power must be disposed of in some way. It is a well established fact that the digestive powers of the stomach have no control over this powerful agent. As it cannot be digested, and as the digestion of food cannot proceed in its presence, nature proceeds at once to banish the unwholesome intruder.

Instead of being digested, alcohol is taken up by absorption by the capillary vessels of the stomach and introduced directly into the blood; by which it is carried to all parts of the system. It is evident, therefore, that alcohol cannot be regarded as food in the ordinary use of the term. But it has been observed that if a portion of alcohol be taken at regular and frequent intervals, the weight of the body will be increased. Numerous carefully conducted experiments prove this to be true. This fact has led many eminent physicians to believe that alcohol when taken into the stomach acts as a tood. But this phenomenon may be accounted for in more strict accordance with the facts without giving it this interpretation. In order to a full understanding of this point, it is necessary that we turn aside a little and inquire into the manner in which food is made beneficial to the system. Every organized being is composed of innumerable minute vesicles termed "cells." These cells are constantly dying and being conveyed from the system, while their places are being supplied by others formed from material derived from the food eaten. This process of composition and decomposition, of birth and death, is constantly going on in all parts of the physical system. When a particle of material has served its purpose in the system it loses its power to further serve the purposes of the system, and its further presence is detrimental to health. The highest state of health is secured only by the prompt removal of this effete matter. Thus it appears that we live only by a constant process of dying Alcohol in the living system, as everywhere else, antagonizes the natural tendency to decomposition. Hence the dead matter that, under the healthy action of the system, would be speedily excreted trom the system, is retained longer than it should be. The result is the weight is increased, but it is by the retention of the old matter that should be cast off and not by the addition of new material obtained from the alcohol. Another argument in favor of the nutritious nature of alcohol is based on the nature of this substance. All forms of food substances may be arranged in two general classes, viz.: nitrogenous and carbonaceous. The former of these goes to make up the various tissues of the animal system, and the latter results in the development of animal heat and carbonic anhydride. Now as alcohol contains so large a proportion of carbon, it was placed at the head of the list of respiratory food substances.

This theory, advanced by so high an authority as Baron Liebig, and looking so plausible on its face, gained at once general acceptance. But it was not long till Dr. Prout demonstrated by experiment that the amount of carbonic acid exhaled from the lungs was directly diminished by the presence of alcohol. Dr. Davis, of Chicago, next took up the question of the development of animal heat from alcohol, and by carefully conducted experiments he demonstrated the fact that so far from the heat of the system being increased under the influence of alcohol it was actually diminished. After taking nutritious food into the stomach the temperature of the body is increased, but after taking alcohol in any form or mixture the temperature soon begins to fall and continues depressed one to two degrees below normal for two or three hours, the extent and duration of this depression being in exact proportion to the amount taken. The world has long labored under the delusion that both the temperature and strength of the body were increased by the presence of alcohol in the system. Dr. Davis's experiments with a very delicate thermometer proved the first a mistake, and an application of the dynamometer showed the last to be an error. The common error on this subject arises from the state of perverted sensibility resulting from the alcohol that has been imbibed.

The individual will assert with great positiveness that he is warmer or stronger while under its influence than at other times, but an application of the proper tests proves his mistake. But it is this appeal to his sensibilities that has misled the world on this subject for generations. In order to a full understanding of this matter, it is necessary to inquire more particularly into the effects of alcohel on the human system.

If an application of alcohol be made to any part of the body and continued for some time, it will be found that the sensibility of that part has been diminished. The nerves with which the poison comes in contact are paralyzed to some extent, thus reducing their sensibility. And this leads us to inquire more fully into the real nature of alcohol. The almost universal opinion is that alcohol is a stimulant, and the exhilaration resulting from its use is offered as a proof of this view. What is a stimulant? There are three classes of medicinal agents that produce different chemical changes in the system and so sustain a different relation to the production and expenditure of vital force. One class operates to produce an increased expenditure of vital force without in any way affecting the supply of that force. These are called stimulants Of this class cayenne pepper, ammonia, and guaiacum will serve as examples. A second class increases both the amount of the vital force and its expenditure; these are termed tonics. Iron, quinine, and the active principle of the barks of poplar, willow, and dogwood, and of tea and coffee, may be taken as samples of this class. A third class retards the chemical changes of the system, and so reduces both the production and expenditure of vital force. Dullness, stupor, impaired sensibility, and unconsciousness, are the results of this class. It is evident that alcohol belongs to this last group. The narcotic or anæsthetic effect of alcohol on the nerves and brain renders the individual less sensible of all outward impressions. This diminished susceptibility renders the patient less sensible of heat and cold, weariness and pain.

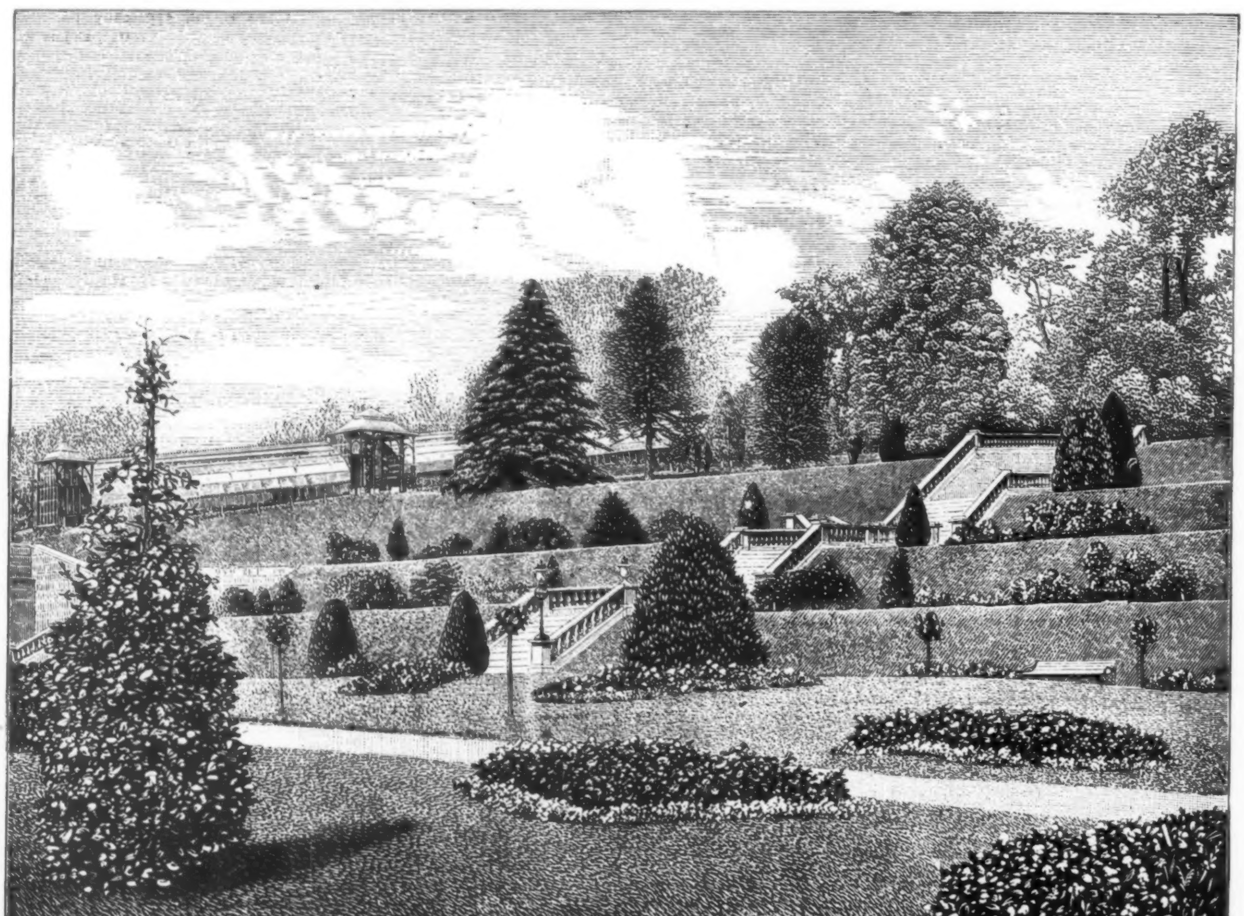
It has long been noticed as a paradox of human action, that the same person will claim that the same alcoholic drink will warm him when cold, cool him when hot, rest him when weary, and soothe him when afflicted. It has long been claimed that when a person becomes weary a portion of alcohol will renew his vigor and remove all sense of weariness. If exposed to heat or cold, he feels the effects of these extremes less acutely if he has imbibed a portion of alcoholic liquors. Now this sense of weariness, the pain felt in the presence of heat or cold, are but sentinels that nature has kindly placed to warn us of the vital powers by these adverse conditions.

When alcohol is taken under such circumstances it adds nothing to the strength or the resisting power of the system; simply renders it less sensible to the evil that is going on—it bribes the sentinei, so to speak, to give no further warning while the ruin of the system is wrought. The sense of weariness is taken away but the exhaustion goes on all the same. The sense of cold or heat is removed, but this does not prevent the individual from dying with sunstroke on the one hand or freezing on the other; but these fatal results are only hastened.

"But," it may be asked, "if alcohol is not a stimulant, why is a man often excited to great nervous and mental activity while under its influence?"

This follows from the anæsthetic nature of the poison. When taken into the stomach, as stated above, the alcohol is taken up at once and conveyed unchanged to all parts of the system. Its first effects are felt at the extremities of the nervous system. These nerve extremities under the paralyzing effects of this narcotic poison lose their power of action and become inert. The vital force that has been sent out from the great nerve-center—the brain—to be expended at these extremities, finding the nerve-fibers inactive—the wires down—is returned towards the nerve-center, producing increased activity in that organ, resulting in exhilaration and increased nervous activity there. As the effects of the poison move back along the nerve fibers, approaching nearer and nearer the brain, this exhilaration increases till in many cases it becomes uncontrollable mental excitement. But after a time, if the dose has been sufficiently large, when all the outposts have been taken, the enemy enters the very citadel of the mind and lays its paralyzing touch on the brain itself. This high state of mental excitement is quickly changed to one of stupidity and sottishness. Thus the very symptoms relied on to prove that alcohol is a stimulant, when correctly interpreted, only prove it to be a deadly narcotic. The delusions in regard to the true character of alcohol and its effects upon the system, that have prevailed not only among the common people but also among physicians and physiologists, have led to errors in practice that have been fraught with unmeasured woe to our race, and have been a sad commentary on the declaration of the wise man, that "wine is a mocker." But with the increase of light on this subject, may we not hope the evils resulting from the misuse of this powerful narcotic poison will speedily cease to afflict mankind?—*Kansas City Review.*

STREATHAM HALL.



SUGGESTIONS IN LANDSCAPE GARDENING.—TERRACES, STREATHAM HALL.

This beautiful country seat, the property of Mrs. Thornton West, stands upon a commanding eminence in the parish of St. David's, Exeter. The mansion, which is a comparatively new one, has been erected in a most elaborate and costly style, and its adjuncts of every description are in strict character with the mansion. The garden, in which horticultural readers are most interested, has been designed and laid out regardless of cost in every detail; the lakes, terraces, statuary, and other adornments being, if there is any fault to find, rather too numerous, but as regards material and workmanship they are of the first order. The existence of such a garden establishment as this, kept up as it is in the most liberal manner, must give a great impetus to gardening in the neighborhood, if, indeed, its influence is not felt a good way from home. The grounds are entered by a massive iron gate set in columns of masonry of an ornamental character, within the portals of which there is a fine lodge at a few yards' distance from the drive. The avenue is much wider than usual—about 20 feet—and is beautifully tapered and leveled from its center to the tile water channels by the margin of the grass verge. There is a neat group of flower beds in front of the lodge, and a considerable addition has lately been made to the grass upon both sides of the drive, which is a well conceived improvement. The broad belts of grass are planted with Conifers and flowering trees and shrubs of the rarest kinds, such as Picea lasiocarpa, Pinus insignis and excelsa, Abies Pinsapo, Wellingtonias, Cupressus, and Cedars, intermixed with flowering Chestnuts and Hawthorns.

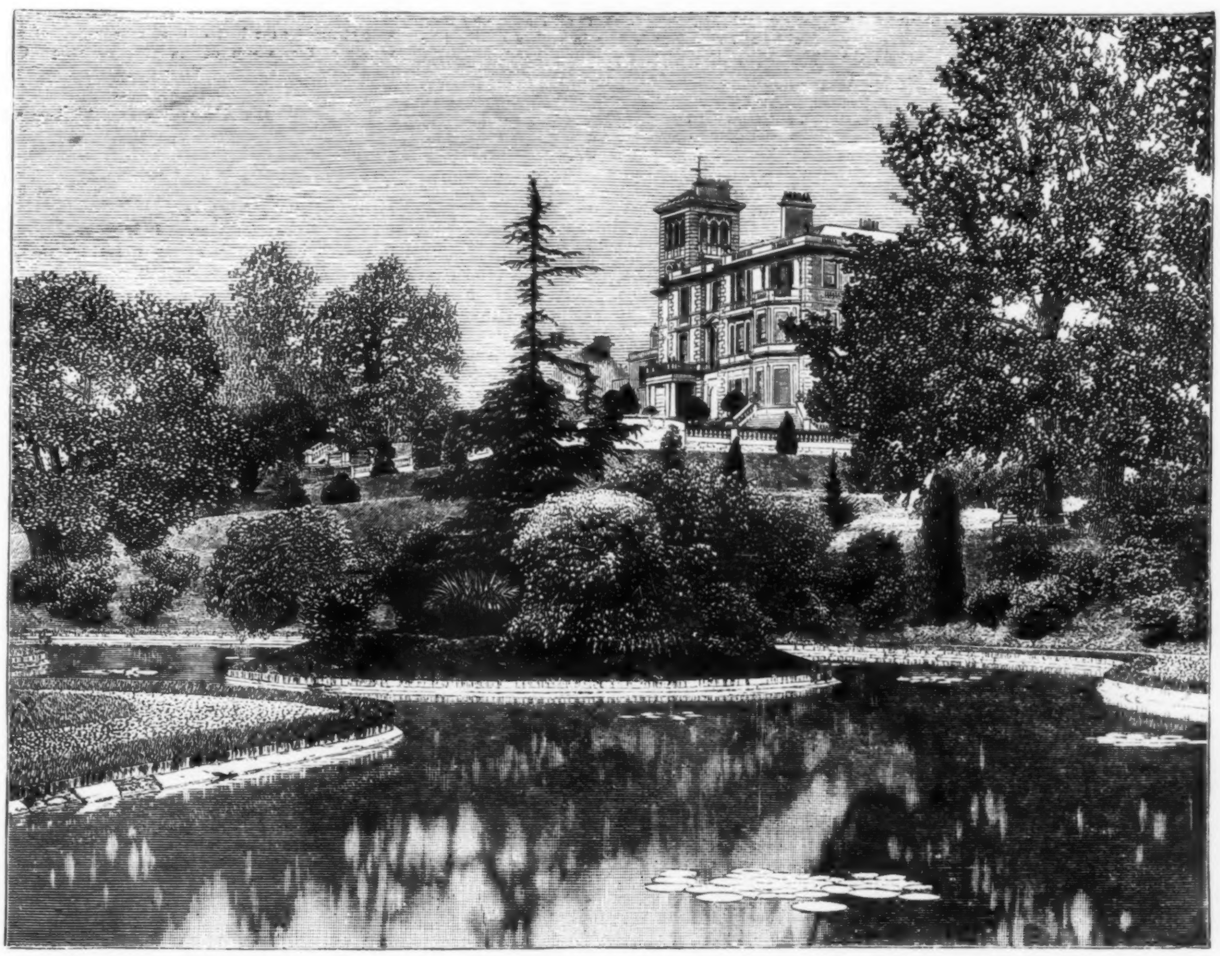
Near to the mansion, or rather within view of it, there are some remarkable specimens of the Turkey Oak—massive trees, in fine health, and having a striking effect from the terraces and principal windows of the house. From here there is an unobstructed view toward Powderham and

Haldon, and a large tract of country richly wooded and diversified. To the right of the Oaks there is an ornamental lake (not a mud pond, as many of them are), with an island in the center. The white and yellow Nymphæas luxuriate in this lake, and are very effective floating upon the surface of the bright clear water. Beyond the lake there is a broad curving band of hybrid Rhododendrons, perhaps the most artistic idea conceived in the laying out of the grounds. The various hues of the Rhododendrons are very striking by the side of the water, and the terraces above them have a tendency to concentrate the vision for the moment, which probably enhances the beauty of this particular view.

In the opposite direction the drive is bordered by a row of Cupressus Lawsoniana and Thujopsis borealis, and these are margined by seedling Antirrhinums and China Roses, which look well under the shade of the deep green Conifers. When the slope is nearly ascended approaching the house, the drive takes a bold sweep to the right, but persons on foot may reach the terrace by the Diana Walk, so called because there is a beautiful statue of Diana in its center. The steps and balustrades approaching the terraces are no doubt ornamental from one point of view, but they are eclipsed by the wealth of trees and shrubs which are met with at every turn in this fine garden. Never before have we seen Hollies and rare Conifers grow so freely under the shade of larger trees as here; and yet the secret is not far to seek. It is a question of cost. A thorough preparation was made before the trees were planted, and notwithstanding the adverse influences of shade and drip the Conifers seem to have established themselves in the rich compost, thrive surprisingly, and are apparently likely to thrive for many years to come.

Vases are freely used upon the second chain of terraces, where there are a pair of perhaps the finest specimens of Retinospora plumosa to be seen in England. The plants are over eight feet high and as much through, and are the most shrubberies. They are grouped by themselves, and make a fine show.

The walled-in garden is surrounded outside the walls with a range of Johnston Brothers & Co.'s patent fruit-houses; and it would be well for gardening if there were more of them in the country. Before noticing the glass department it may be as well to state that they are not of the ordinary kind; but I do not say they are better for cultural purposes because they are costly. The forcing pits, I noticed, were filled with early crops, and houses of Melons and Cucumbers were both early and of first-rate quality—indeed, a house of Gilbert's green-fleshed melon would have done even that renowned Melon grower credit, so fine were the fruits, and so beautifully were they finished. A span-roofed fernery contains a splendid collection of Ferns and mosses planted out. The path is up the center—a broad grating; and two beds having irregular surfaces composed of rockwork are furnished with Ferns. The tall plants comprise an upright growing species of Davallia; Nephrolepis exaltata, looking all the better for being planted out; Asplenium Belangeri, Blechnums, Pteris argyrea, Asplenium fœniculaceum and bulbiferum, and a large variety of Adiantums, which, together with mosses and Selaginellas, form the groundwork of the beds. In the propagating house, which is fitted up with all modern improvements, there is a good stock of foliage plants for furnishing, and mosses and Ferns for the same purpose, good baskets of Achimenes and pans of Campylobotris refulgans. Peaches in a long lean-to house were a fine crop, large in size and highly colored. The great house of the place is, however, a plant stove in three tiers of spans, containing an extensive and remarkable collection of plants. Tall Palms and Ferns are arranged down the center, noble specimens of all the leading kinds, which are too extensive to enumerate in detail, and many fine foliage plants, including a superbly grown specimen of Cyanophyllum magnificum, with leaves over two feet in length.



SUGGESTIONS IN LANDSCAPE GARDENING.—GROUNDS, STREATHAM HALL.

fascinating objects of their kind upon the place. There are also large specimens of the Golden Yew (Taxus baccata elegantissima), and various others. It should be stated that the house is surrounded with chains of terraces one rising above another upon three sides. From the south terrace there is a good view of Exeter Cathedral and the surrounding country for many miles. Between the grounds and the park the show of Rhododendrons in spring is brilliant in the extreme, and the scroll-beds upon the terrace were just beginning to show color at the time of our visit. Looking eastward there is the large Camellia-house and conservatory, and further to the left a steep chain of four terraces planted with the choicest of American plants. The Camellias—plants worthy the house and the garden—are planted out, the roof is ornamented with creepers, and the side stages with flowering plants.

The conservatory is a large oblong building, and is furnished with a collection of hard-wooded, semi-hard-wooded, and other flowering plants, the latter, of course, predominating for the sake of supplying the necessary degree of color to adorn so large a house. Acacias of sorts, Chrysanthemum fruticosum, Salvia patens, Fuchsias and Pelargoniums of the decorative section are freely intermixed with Orange trees, Myrtles, and others already mentioned. From the grounds above the conservatory there is a good view of St. Michael's Church, Exeter, but the plants and trees are of so choice a character that the horticulturist is more inclined to look at and admire them than distant objects however pretty. The coniferous trees are very plentiful, and the shrubbery beds and borders are alive with flowering plants, the choicest of everything that is useful and beautiful. The herbaceous garden is simply a continuation of the There is a whole house devoted to the cultivation of the Stephanotis, which is trained upon the roof over a collection of Ferns in pots, which consist of many fine specimens of Polypodiums, Davallias, Lomarias, Blechnums, and other kinds of dwarfer habit, as well as mosses and Selaginellas. The ranges of vineries are proportionately extensive, and the crops are good throughout. Of course at such an establishment it is needless to say that early and late Grape growing is carried on as a matter of routine business, just as the forcing of Pines, Strawberries, and vegetables is carried on in a range of houses in five divisions, where every plant is in its place and in good health. The Orchid houses I omitted to mention, but where all is done so well it is needless to say that the collection is well grown, and that under the management of Mr. Franklin, the head gardener, a great future is in store for gardening at Streatham Hall.—*The Gardener's Chronicle.*

DISINFECTION BY HOT AIR.—Koch and Wolfhügel, in experiments made to determine the disinfecting power of hot air, were led to the following conclusions: 1. Bacteria are destroyed by being exposed to a temperature of a little over 100° C. for an hour and a half. 2. Spores of brewer's mould require for their destruction an exposure for the same time at 110°-115° C. 3. Bacilli are killed only by three hours' exposure at 140° C. 4. The heat of hot air penetrates articles so slowly that in three or four hours' heating at 140° C. of small objects, such as a bundle of clothes, etc., disinfection was not secured. 5. Five hours' heating at 140° C., necessary to certain disinfection, does serious injury to most articles.

SILK-WORM CULTIVATION.

Report by U. S. Vice-Consul JOHN GRIFFITT, of Smyrna, Turkey.

THE efforts that are being made at present in the United States to extend the culture of the silk-worm leads me to make this report, trusting it may be useful.

I have been engaged for many years in raising silk-worms, my object being the study of their diseases, and, after years of experiments, have succeeded in obtaining healthy grain, the *basis* of *success in silk culture.*

I was induced to make these trials in the hope of alleviating the losses that the peasants in Turkey have suffered for the last twenty-five years, and have endeavored to interest the governors of this Vilayet in my work, in order that I might obtain the moral support of the government, but thus far without success.

The loss suffered by Turkey since 1857, when the silk-worm disease first spread so violently, is incalculable. I remember the time when the wife of every gardener in the vicinity of Smyrna obtained from her crop of cocoons a sufficient return to enable her to pay for the clothing of her family for the entire year. This fatal disease swept away our beautiful indigenous races, and this branch of industry was almost abandoned. Many mulberry trees were uprooted, those that were retained being kept by the gardeners solely for the use of their branches.

There were at that time three large silk reeling factories, worked by steam, where hundreds of women were employed. Work had to be abandoned for want of cocoons. The Japanese race was introduced later on, with but partial success. There is a very great difference between the indigenous and the Japanese races; it requires at least double the number of the latter to give the same weight in cocoons; that is to say, if it requires 250 fresh cocoons of the indigenous race to weigh a pound, it requires 500 of the Japanese, and the quality of the silk is much inferior.

I obtained some years ago a quantity of indigenous grain of a very fine race, but very much diseased. I raised the worms from the moment they were hatched in separate cells, in order that the diseased ones might not infect the healthy (all the worms of a diseased moth are not diseased), and from the few healthy ones I obtained my present race, which I have since then continued to improve, and I now find it in every way superior to all other races I have raised, not only as to the vigor of the worm, but also as to the weight of the cocoon and the quality and quantity of the silk it yields. From one ounce of 30 grammes I obtain invariably from 150 to 155 pounds of fresh cocoons, 12 pounds of which, just taken from the brushes, yield over one pound of silk of the best and finest quality. Another great advantage of my race is that it has not more than 4 to 6 per cent. of double cocoons, while other races have from 15 to 30 per cent.

In my experiments in raising grain I find that double cocoons should never be used for reproduction. On the contrary, they should be carefully avoided, as the worms obtained from grain the moths of which issued from double cocoons have a tendency to form double cocoons the next season.

All the grain I raise is manufactured on the system of the distinguished Pasteur, to whom sericulture owes everything in the regeneration of the silk-worm. Each moth is placed on a small cloth to lay its eggs, and when finished laying it is pinned by its wings to the cloth, to prevent it from falling off. It is afterward examined with a microscope of a magnifying power of 500 diameters, and when found diseased, which can easily be ascertained by the appearance of cor

puscles on the disk, the grain is thrown away. In this way I am certain that my grain is free of one of the principal diseases of the silk-worm, the one that makes the greatest havoc, called "pebrine." The corpuscles are easily distinguished; they are of a brilliant oval shape.

The other great disease, known by the name "flacherie," can easily be ascertained without the aid of the microscope by watching the worms in their last age. If there are few deaths at that period, and if the worms do not hesitate in mounting the brushes to spin their cocoons, it is safe to consider them free from that dread disease which carries them off in their last age, just when the educator counts upon the probable reward for labor and outlay. The grain, when examined, is washed off the cloth after the lapse of a month from the time of laying. The washing process is as follows: A sufficient quantity of soft water is boiled over night, and there is then added thereto 10 per cent. of alcohol. The grain is washed off in this water, and then exposed to the air in a shady place, to dry as rapidly as possible. When thoroughly dry, say in two or three days, the grain should be placed in a box of perforated zinc, containing drawers of the same material, each layer of the grain not to exceed a centimeter in thickness. The box containing the grain is hung from the ceiling in a dry, airy locality, and kept there till the next season. The cold of winter need not be feared; it is, on the contrary, very beneficial to the grain.

In March I have my nursery whitewashed and thoroughly cleaned, and all the utensils exposed to a fumigation of sulphur. Toward the end of March the mulberry tree, in this climate, begins to bud, and when the leaf attains the size of about a silver dollar I place my grain in thin layers in a room heated with an earthenware stove and gradually bring the temperature to 70° Fahrenheit, taking care to keep a vase of water constantly on the stove. The grain begins to hatch in six or seven days, and continues to do so for four or five days. I throw away the last day's issue, as the worms are not numerous, and weak, although not sickly. Each day's issue is kept apart; to the first day's issue I give two feeds of leaf, cut up very thin with a clean knife, and I give an extra feed to each day's after-issue. The first day's issue I place on the lowest frame of the stand, those of the second day on the one above, and so on. The object of this is to enable the worms of the last day's issue to reach the others in their first molt, as the higher the worms are placed on the stand the greater is the heat, and this, joined to the extra meals, enables them to make their first molt with those hatched earlier, thus forming a regularity in the education. In the second, third, and fourth ages I feed my worms four times a day, at 5 and 10 A.M., and at 3 and 8 P.M. The feeds are given with great regularity. In the last age they are fed constantly from 5 A.M. to 11 P.M., and when I raise worms in my large nursery I employ extra hands to continue feeding them during the whole night, not in large quantities, but never allowing them to remain without food. It is indispensably requisite that the worms should not be crowded, especially in their first ages. I give to the worms of one ounce of grain, in their first age, a space of 2½ square yards; in their second age, 5 square yards; in their third, 10 square yards; in their fourth age, 25 square yards, and in their fifth and last age there should not be more than 500 or 600 worms per square yard. The leaves of the wild mulberry are preferable for the first three ages, and the leaves of the grafted mulberry should be given for the fourth and fifth ages. The leaves should be gathered after the dew has evaporated, and if wet by rain they should be dried before they are given to the worms. The leaf is cut up to the end of the third age; after that the leaves are given entire to the worms.

I clean my frames twice during the second, third, and fourth ages. Once immediately after their first meal, after their molt, and again the day before they began to molt. This is done by placing sheets of thick paper, pierced with holes sufficiently large to allow the worms to pass through. These pierced sheets of paper are placed on the worms, leaves are placed on them, and in a few moments the entire batch will crawl upon the leaf. The papers with the worms on are then raised and placed upon a clean frame; if a few should remain in the litter I put them apart from the others. The litter should be raised very carefully; no dust from it should be allowed to spread in the room.

The last age of the worm is certainly its most critical one, and requires the greatest care. At this period the worm eats twice as much as during its first four ages, and the litter remaining on the frames, together with the dejections of the worms, renders the air impure and unhealthy. Consequently the frames should be cleaned frequently, and there should be a constant renewal of fresh air. Diluted chloride of lime should be kept in each corner of the room during the entire period of the fourth and fifth ages.

Five days after the worms have formed their cocoons they should be taken off the brushes with great care, for if any diseased worms remain on the brushes in a state of putrefaction the good cocoons would be soiled and consequently depreciated in value. All imperfect cocoons should be separated and exposed to the sun for some days to destroy the chrysalis; the good ones steamed. The steaming process for destroying chrysalides is far preferable to any other; the silk is not injured thereby, as it is apt to be by baking or exposure to the sun. I steam them for twenty minutes, the water constantly boiling, and this I find sufficient to destroy the chrysalis; I then place them on the frames in thin layers to dry, and after this is effected the cocoons should be reeled off as soon as possible.

By raising the worms of healthy grain, such as I have above described, and by following the foregoing directions, it is impossible not to succeed in obtaining a good crop of cocoons. Years' experience has proved to me that, ignorant as some of the educators have been to whom I have given grain, they have invariably obtained a remunerative crop of cocoons, and even sometimes quite as good as my own.

In December next, the proper time for shipping, I will send some ounces of my grain, together with a sample of my reeled silk, to the Department of State.

Smyrna, July 5, 1882.

A Luxury for Cattle.—We do not say this hastily, but with the conviction derived from feeding late cut timothy and bright oat straw. With four feed racks in our yard—two kept filled with timothy, one with prairie hay, and one with bright oat straw, the latter was consumed first, and the other neglected until the last vestige of the oat straw had disappeared. It was the instinctive act of the urchin repeated. He took his cake, pudding, and pie first, and reluctantly finished off his dinner on the drier and less palatable bread and butter. Our late cut hay was merely a "fill up," to give their digestive apparatus the necessary distention so needful to ruminants, and that is about all late cut hay is good for anyway.—*Chicago Herald.*

THE PRUNE TRADE OF BORDEAUX.

Report by George W. Roosevelt, United States Consul.

Perhaps the greatest favorite among the foreign dried fruits sent into the United States is the French prune. The raisin, the date, and the Turkish prune hold their places in the market, but the delicious *prune d'ente* is very properly the most popular with Americans, who are said to be the only people who know how to cook them.

The greater part of the fine prunes that are raised for exportation are produced in the department of Lot-et-Garonne, in orchards of especially grafted plums, which cover an area of about 500,000 acres. These orchards are the property of peasant farmers, and the acreage is constantly on the increase, owing to the failure of the vineyards, which are being replaced in the prune region by the more hardy plum tree.

Prune trees are generally planted about 20 feet apart, with other crops growing between them. The trees are usually healthy, but in some seasons require great care to protect them from small caterpillars.

The orchards being small and the peasants numerous, these marauders are usually dispatched in detail. Prunes grown near the river Lot are of a very dark violet color, and are possessed of a very delicious flavor, and this is the variety which is packed with so much care in fancy boxes for the confectionery trade.

The peasants begin to pick the prunes after the middle of August, and remove them from the trees only when they are dead ripe. Then they dry them in Dutch ovens, which are heated to a given temperature by a fire inside the oven; the fire is then taken out and the prunes placed in the oven on trays. The peasants do this drying so imperfectly that exporters are often compelled to put the prunes through a further process before they are fit for exportation, for, as the value of the prune largely depends upon its size after drying, the peasants stint that process to preserve the bulk. When properly cured they are cooked through, and the secret is to accomplish this desirable feat and still maintain the size and color of the prune.

The crop varies greatly with different years, but the maximum was probably reached in 1875, when 10,000,000 pounds were produced. A great quantity of prunes is consumed in France, and there are, of course, many varieties which come very much cheaper than the prices shown by the following table. The more ordinary varieties are not, however, exported to the United States, though they are sent in considerable quantities to England, Canada, and Germany. The reason why they are not sent into the United States is very apparent when it is considered that the duty on first-class prunes is 1 cent per pound, while that on the ordinary ones, called "plums," is 2½ cents per pound. In the English markets the large ones are called plums and the small ones prunes:

MARKET PRICES PER 100 POUNDS FROM 1876 TO 1881, INCLUSIVE.

	Minimum.	Maximum.	Average.
Prunes per pound:	Francs.	Francs.	Francs.
50 to 55	62	132	90
60 to 65	54	104	70
70 to 75	47	90	58
80 to 85	37	79	50
90 to 95	27	69	42
100 to 105	21	62	36

These averages are calculated upon six years ending with 1881, and they represent the net cost of the fruit as bought from the producers on the country markets as nearly as it is possible to ascertain them. It will be observed from the above table that the value of the fruit is in proportion to the size, or, which is the same thing, the number required to make a pound, the largest ones always fetching the highest price. The men, women, and children employed in the packing and curing receive from 10 to 80 cents per day and board themselves, and they work from 6 A.M. to 7 P.M. The total value of the prunes shipped from this port to the United States in 1880 was $136,514.90, and in 1881 $362,225.92, showing an increase of $220,711.02.

Bordeaux, June 6, 1882.

A SUMMER WITHOUT RAIN.

The summer of 1882 will be long known as the summer without rain. The drought, however, was somewhat local, extending over the New England States, and being most severely felt in Eastern Massachusetts. At our farm in Essex County, only three-sixteenths of an inch of rain fell in the interval between the 5th of July and the 5th of September, and during that period the most intense heat prevailed. The fierce rays of an unclouded sun were poured upon growing vegetation for sixty consecutive days, the thermometer ranging during the time between 80° and 90° F. The crops of every kind were virtually destroyed, and tillage lands and pastures have been dried so that not a green blade of grass can be seen. It is the first summer for a quarter of a century that the corn crop at the farm has failed; indeed, not for a century, probably, has the corn crop been so effectually destroyed by drought. It is the crop *par excellence* which withstands the influence of long-continued dry weather, and instances are exceedingly rare when corn has been materially injured from the withholding of rain. This season it has been almost a total failure in several of the New England States, and the dwarfed plants have been cut up and fed to animals taken in from the parched grazing-fields. Corn planted for ensilaging has also failed, and many silos will remain empty during the winter. It is a great hardship for farmers to see their crops dry up in the fields, and many are greatly discouraged. Potatoes have also failed, and very large areas were devoted to their culture the past season, owing to the scarcity and high prices which prevailed during the spring months.

The hay crop in New England was a large one, but in the absence of a second crop, and from the need of farmers saving their herds of animals by feeding from their barns in the hot weather, the winter's stock of hay will be small. Altogether, the season has been one of the most discouraging experienced by farmers for many years, and the aggregate of losses will be many millions. If the New England States were as isolated as they were one hundred years ago, a famine would probably occur, or at least there would be a scarcity of food which would cause great anxiety and suffering. But with railroads penetrating into the South and far West, an abundance of food, raised under more favoring circumstances, will be brought to our doors, and all will be fed. It is almost, or quite, impossible for crop failures to extend over the vast territory of the United States; and probably the time will never come when there will be an alarming scarcity of food in this country. It is something to live in such a country, for, of all calamities, none can be greater than famine.—*Boston Journal of Chemistry.*

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